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THE SERVICEABILITY OF CERTAIN READY-MADE RAYON GARMENTS

by

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INTRODUCTION

Rayon fabrics have gained in popularity during the past few years and have tended to replace silk for many uses. In 1937 approximately 20,000,000 pounds of rayon were used in the manufacture of fabrics for woven-goods undergarments as compared with 5,500,000 pounds of silk (10). Each succeeding year there has been a definite increase in the acceptance of rayon fabrics for such clothing. A survey of the market in one locality[1] showed the extent to which rayon slips have come to replace those of silk. Among 27 groups of slips of different qualities or made by different companies, 19 were made of all rayon fabrics, four of rayon and silk, and only four were made of pure dye silk.

With the exception of cotton, rayon is probably found more frequently on the market than any other fiber. Because it can be made to look like silk, linen, wool, or cotton it has been a source of confusion to the consumer. Consequently, the Federal Trade Commission rulings (8) of

[1]Study by Caroline Boyer in 1940 filed in Clothing and Textiles Department, Kansas State College of Agriculture and Applied Science.

October 1937 are of practical importance. These rulings make it compulsory for manufacturers and retailers to label and sell rayon products as such. It is important also that the consumer be able to recognize the two distinct types of rayon because of the differences in care required by each. Viscose and cuprammonium rayons are essentially regenerated cellulose; the acetate rayons are cellulose acetate (8). It is the acetate fabrics that require special handling. Some cleansing agents such as chloroform and acetone dissolve acetate rayon. It will melt or fuse at high temperature, and should be ironed with care. However, some acetates have been subjected to chemical treatment which partially converts them back to regenerated cellulose rayon (8) and the difficulties of handling are decreased thereby. It is unfortunate that the rules for the industry do not make mandatory adequate labeling of fabrics. Viscose constitutes the majority of all rayon consumption, with cellulose acetate second in importance (17). Much uncertainty remains as to the service to be expected from such ready-made rayon garments as are on the market today. Lack of serviceability may be attributed to the character of the fabric as it is influenced by the type of fiber used and the construction of

the fabric. It also may be attributed to the construction of the garment or to the effect of individual differences in the wearers on service qualities.

The purpose of this study was to ascertain the character of fabrics found in certain rayon slips; to ascertain the durability of the various fabrics as shown by the combined effect of wear, laundering and aging; and to ascertain the effect of wear given by different individuals upon slips of similar design and quality.

STATUS OF KNOWLEDGE IN THE FIELD

Factors Affecting Wearing Qualities of Rayon Garments

The need for studying the serviceability of fabrics under conditions of actual wear and for evaluating them on other than physical and chemical tests alone has been shown by a recent investigator. Certain tests which are sometimes used to determine the serviceability of a fabric predicted inaccurately the probable wear.

Sommaripa (15) in cooperation with two large retail establishments carried on a significant study of the wearability of woven rayon slips. He reported the results of wear tests of 800 slips worn by factory and store workers.

The slips were washed, ironed, and mended in the usual manner and were discarded when the wearers considered them worn out. The study shows that raveling of raw edges was the major cause for repairing and discarding of viscose slips. The major causes for discarding slips made from acetate fabrics were holes near seams and burned holes.

Wear tests indicated that a slip made of a rayon fabric of 72 by 48 thread count was discarded after an average of 485 hours of wear. Based on the retail price of $0.49 these slips would cost $4.72 a year to wear them. The same wearers discarded after 68 days a similar type slip made of a 92 by 68 fabric selling for $0.69. The annual cost of this slip would be $3.64 or 23 percent less than the $0.49 slip. The first slip required 39 repairs per year as compared to 15 for the one last mentioned. The study showed that the possible service rendered by a slip of 92 by 68 count could be much increased at an expense of less than $0.01 per garment, through the use of covered edge seams. It was estimated that the use of this seam would double the life of the garment, bringing the annual cost down to $1.84, and would eliminate seam repairs.

Sommaripa recommended a slip made with the lock stitch seam and of French crepe of 104 by 72 thread count. A

test among 150 working girls indicated the average life of this slip to be nine months and no seam repairs were required. The annual cost was only $2.21. The author stated that the bias seam was effective in preventing the seam pulling out even in fabrics with low thread count where resistance to slippage was only two pounds. However, such fabrics raveled badly and the seam lasted only as long as the raw edge lasted. Records of the service given by viscose slips showed that when the seams were protected to prevent raveling and the garments were given normal wear, they were discarded on account of holes and fuzz. Holes near seams were an important reason for discarding acetate satins and taffetas. Here tensile strength had no forecast value. A fabric which had holes near seams after 59 washings retained a tensile strength of 52 pounds in the warp and 27 pounds in the filling. It was the resistivity to the heat of an iron which was important. Viscose fabrics of similar construction did not show holes near seams. In a paper taffeta made with viscose filling the condition after 24 washings was, on the average, 2.6 holes. After the same number of washings a faille taffeta of acetate rayon with the same tenacity fillingwise but stronger warpwise showed 3.8 holes near seams.

A recent investigation of the wearing qualities of ready-made silk slips was made by Ekstrom (4). In this study conclusions were reported concerning the effect of wear different individuals had upon clothing, how the construction of the fabric and garment affected the serviceability and to what extent price indicated quality. The method of procedure of the present study was in part suggested by the above mentioned test. Results of these two studies concerning the serviceability of ready-made silk and ready-made rayon slips may be compared.

Six groups each consisting of five bias silk slips of six different qualities or made by different companies were purchased. The slips varied in price from $1.00 to $3.00. The purpose was to ascertain the character and durability of the various fabrics found in the different slips, and to rate the combined effect of wear, laundering, and aging on the fabrics. It was concluded that a direct relationship seemed to exist between service qualities of the fabric and the number of warp and filling yarns per inch, also between service qualities and balance of yarn. The balance of threads in the best quality was 5:3, the others about 2:1.

No relation seemed to exist between the weight of the wearer and the place on the slip where wear first appeared, nor was there a relationship between the activities of the wearer and the place showing wear. It was thought, however, that the wear given a slip varied directly with the size of the wearer.

From this study it was also concluded that price seemed to be an indication of quality, and that economy does not generally result from the purchase of low priced slips. The greatest service was rendered by the highest priced slip. This service may be accounted for in that the fabric was of better quality and the construction was superior to any of the other slips. The fabric showed a higher breaking strength, better balance of yarns, higher thread count, and no insoluble weighting. The lock stitch seam construction resulted in seams that would not pull out and were stronger than the fabric.

Poor service rendered by the slip of lowest cost was due to low thread count, poor balance of thread, and high percentage of weighting. Most fabrics used in silk slips were weighted to the extent that serviceability was lessened.

Factors Affecting Service Qualities of Rayon Fabrics

A number of investigators report findings relating to the service qualities of rayon fabrics. Conclusions based on these studies give much information. However, in some cases laboratory tests of the fabric did not forecast results that have been shown in actual wear.

In a study in 1930 of the effect of heat and light on various types of rayon fabrics, Breckenridge, Edgar and Cranor (1) found viscose was more resistant to the effect of light than acetate or cuprammonium rayon.

A second study concerning the effect of light and of heat on the breaking strength and color change of viscose and cellulose acetate rayon fabrics was made by Houston (7). Materials used included three white viscose and three white cellulose acetate rayons. Conclusions based on findings were that heat and light affected the dry and wet breaking strength, elongation, and color changes of white viscose and cellulose acetate rayon fabrics. Heat also lowered the breaking strength of viscose rayon fabrics more than that of cellulose acetate rayon fabrics. A third conclusion was that the color of viscose rayons was changed more by heat than was cellulose acetate.

The results of tests on the wearing qualities of lining fabrics made from synthetic yarn have been reported by Simon (12). In so far as the wearing quality was related to the kind of fibers used, all acetate fabrics were superior to acetate warp, viscose filled fabrics, and that acetate-warp, viscose filled fabrics were superior to all viscose. He found, however, that a single sample of all viscose might outwear a single sample of all acetate in identical construction and color.

A study of the serviceability of certain rayon fabrics as determined by laboratory tests was made by Crawford at Kansas State College (3). Ten pieces of material and two slips were purchased. The fabrics were all moderately priced, varying from $0.21 a yard to $0.69 a yard. Their width varied from 38 to 41½ inches. Six viscose fabrics were secured: one crepe, three satins, and two taffetas; likewise six acetate fabrics: one crepe, two satins, and three taffetas. An attempt was made to obtain fabrics of like construction in similar thread count. It was found that the high count acetate taffetas are the most durable rayon fabrics for women's service garments. These fabrics were satisfactory in breaking strength, although not so high as satins, and a fair degree of balance existed be-

tween warp and filling strength. Acetate taffetas were superior in their ability to withstand the strain that produces slippage, and were among those fabrics that shrank but little. The qualities of durability possessed by rayon taffetas may be offset in part by the fact that they are so closely woven that they prevent the passage of air. They may retain body heat and for this reason be undesirable for certain uses.

METHOD OF PROCEDURE

A group of six rayon slips of six different qualities or made by six different companies, making 36 slips in all, were purchased at retail. They were of the color known as tearose and made of plain woven fabrics. A description of the six groups of slips is given in Table 1.

The slips were all similar in design with four-gored skirts, and yokes in both the front and back. Two of the brands had only single yokes in the back, but double yokes in front as did the others. With the exception of one group which was cut on the straight of the material all slips were made on the bias. Four qualities had shadow-proof panels. Figures 1 and 2 show the cut of the garments

Table 1. Cost, design, and construction features of the six groups of rayon slips.

Slip	Cost	Design of Slip			Seam		Stitching	
					Kind	Finish	Kind	Per inch
A	$1.69	4-gores:	bias	shadow panel	lapped	pinked edge	lock	24
B	1.65	4-gores:	bias	-	lapped	pinked edge	lock	32
C	0.98	4-gores:	straight	shadow panel	fell	-	plain	11
D	0.98	4-gores:	bias	shadow panel	lapped	pinked edge	plain	12
E	0.79	4-gores:	bias	-	fell	-	plain	18
F	0.59	4-gores:	bias	shadow panel	lapped	pinked edge	plain	15

EXPLANATION OF PLATE I

The six groups of slips were similar in design.

Fig. 1. Front

Fig. 2. Back

PLATE I

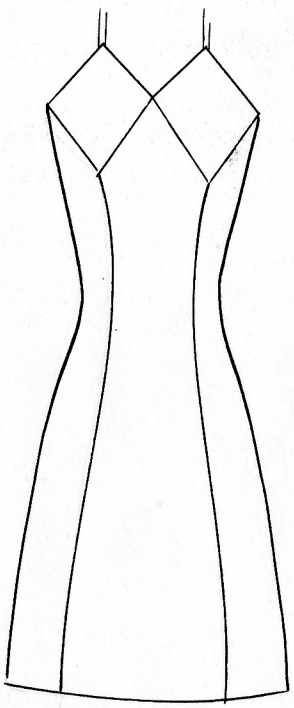

Fig. 1

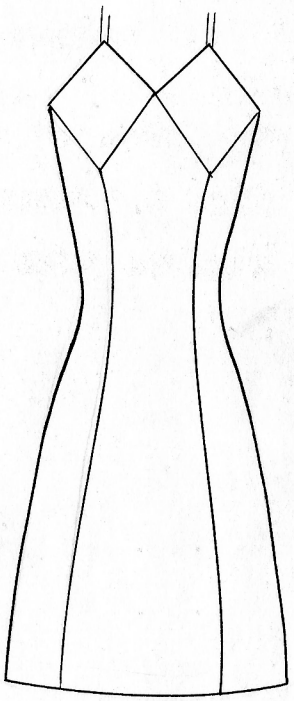

Fig. 2

used. In Figs. 3 to 8 samples of the materials used in each of the six groups of slips are shown.

Two types of seams were found. The slips in four brands were made with the lapped seam and pinked edge. Lock stitches were used on two of these. Plain machine stitching held the seams of the other two as well as the two finished with fell seams. The retail prices of the slips ranged from $0.59 to $1.69. The sizes of the slips purchased to be worn were from 29½ to 38.

Two slips of each quality, 12 in all, were kept as controls for laboratory testing. The other four slips in each group were subjected to wear. Each of the six groups of slips was referred to by a letter and each slip by a number, as, A1, A2, A3, A4.

Similarity of thread count and thickness of fabric were taken as indications of the similarity of the slips comprising each group. Since there were no selvages on the slips so that direction of warp and filling could be ascertained, it was assumed that the higher thread count indicated the warp and the lower count the filling.

EXPLANATION OF PLATE II

Sample of each group of slips.

Fig. 3. Slip A

Fig. 4. Slip B

Fig. 5. Slip C

Fig. 6. Slip D

Fig. 7. Slip E

Fig. 8. Slip F

PLATE II

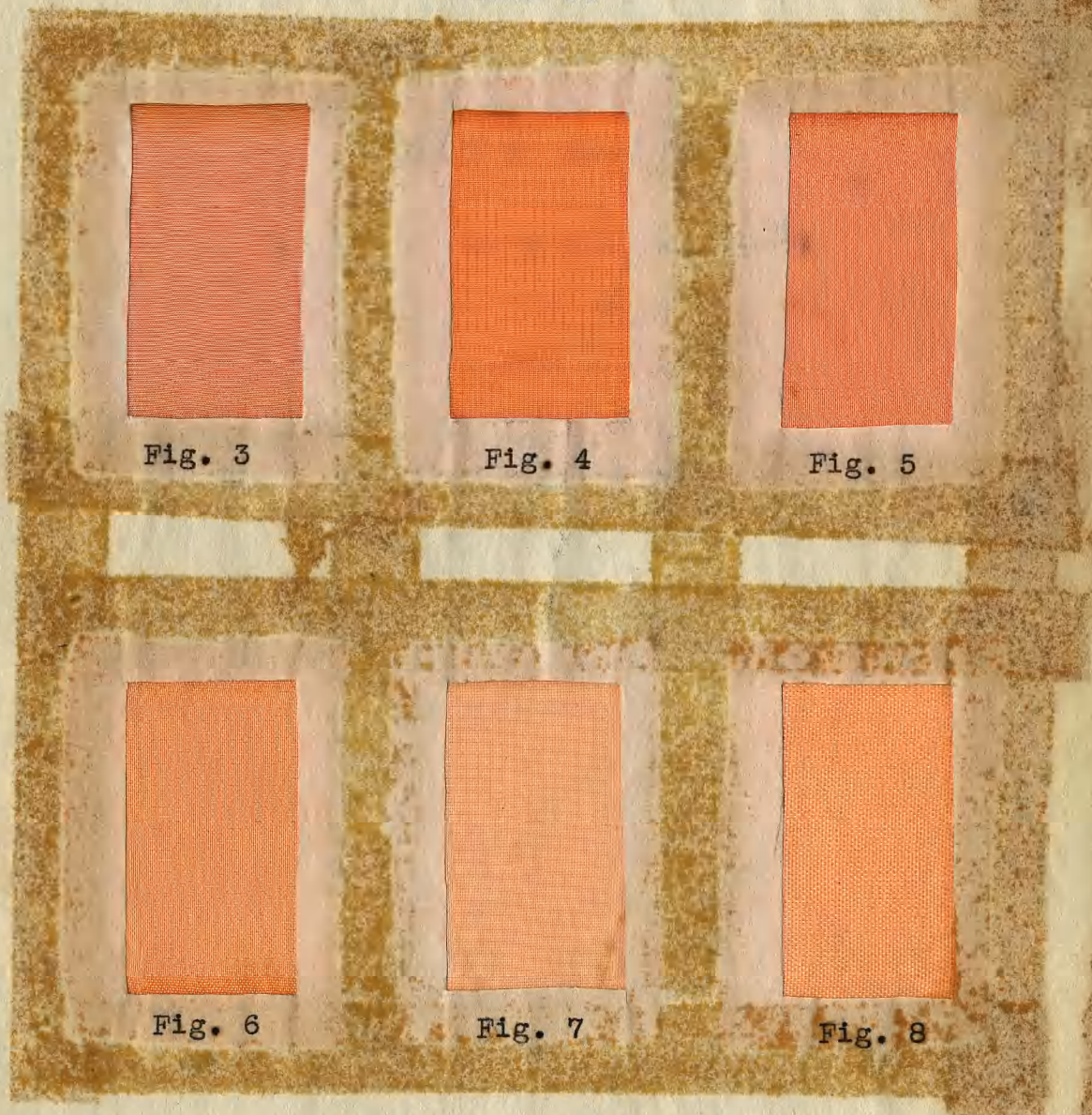

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Serviceability Records

Four slips of each group, 24 in all, were worn by business and professional women. The time of year during which they were worn was from August until June. At the end of each 500 hours wear all slips were checked by the investigator, and if in suitable condition were returned to the wearer for additional wear.

Each wearer was given directions for wearing and laundering the slip, a questionnaire concerning the wearer of the slip and the service record of the garment, and a chart for recording the number of times the slip was worn and the number of times laundered. The above listed forms will be found in the Appendix.

At the end of the study each slip was inspected to determine the effect of wear, of laundering, and of aging. The fabric was analyzed for breaking strength and elongation. Also, at the end of the study a portion of the fabric of the control was analyzed for breaking strength and elongation to determine if there were any effect of aging.

Fabric Analysis of Control Slips

Tests were made on the fabrics to determine thread count, thickness, breaking strength and elongation, yarn slippage, shrinkage, weight per square yard, and the percentage of sizing and finishing materials according to the methods recommended by Committee D-13 on Textile Materials (2).

The specimens were prepared for wet and dry breaking strength and elongation as for the raveled-strip method described by Committee D-13 of Textile Materials (2). Fabrics were tested both warpwise and fillingwise. They were kept for two hours under standard conditions and broken in a Scott Tester. Elongation was autographically recorded.

The fiber content of the fabrics was identified microscopically from cross-sections of the fibers which had been imbedded in cork and mounted in glycerine (11). Specimens were prepared by the Viviani cork method. A sewing machine needle was threaded with dental floss and pushed through a cork. The bundle of fibers was placed in the loop made by the floss and pulled into the cork by removal of the needle. After a drop of collodian had been applied to the end of

the cork to hold the fibers in place, cross-sections were cut as thinly as possible with a razor blade and mounted in glycerine. The mounts were studied under magnification with a 4 mm. objective and a 10 x ocular.

The twist of the yarn was determined in a Suter Twist Tester by a variation of the method recommended in Handbook of Industrial Fabrics (5). The ply method of determining yarn number was used. To avoid any change in the twist of the yarn to be tested, each specimen for testing was cut approximately one-fourth inch wide and 13 inches long. This was inserted in the twist counter with the clamps set 10 inches apart. All, except one of the yarns, were cut away. The yarn was then untwisted until all the fibers lay parallel. Ten determinations were made and the number of twists per inch was calculated.

Specimens to test the effects of abrasion were prepared according to recommendations given in Handbook of Industrial Fabrics (5). One warpwise and one fillingwise specimen cut from each fabric measured 26 by 6 inches. These were conditioned for two hours under standard conditions. They were abraded 100 strokes, using an abrasion machine designed at the Massachusetts Institute of Technology. The effect of abrasion on breaking strength and

elongation was determined by the raveled-strip method, approved by Committee D-13 on Textile Materials (2).

Fabric Analysis of Worn Slips

At the end of the study each worn slip was tested to determine the breaking strength and elongation. An effort was made to take the specimens for testing from about the same area on each slip. Measurements were taken on the bias slips six inches from the hem along the seam. A strip of material was cut seven inches wide and as long as the width of each panel would allow. Three warpwise and three fillingwise specimens were prepared for the raveled-strip method from each of these sections. Measurements on the straight slip were also taken six inches from the hem. A piece 12 inches long warpwise and seven inches wide fillingwise was taken from the center of each panel and cut for the raveled-strip method. Breaking strength and elongation were again determined by the methods recommended by Committee D-13 on Textile Materials (2).

EXPLANATION OF PLATE III

Specimens for testing breaking strength of all worn slips were cut from each panel as indicated in diagram.

Fig. 9. Slips cut on bias of material.

Fig. 10. Slips cut on straight of material.

PLATE III

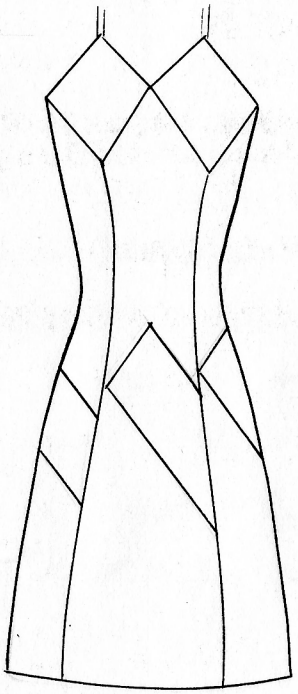

Fig. 9

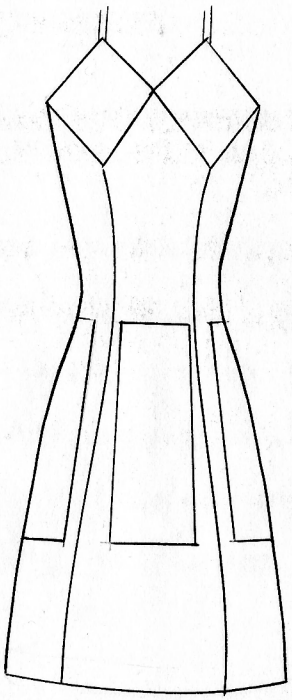

Fig. 10

FINDINGS AND DISCUSSIONS

Twenty-four women cooperated in the study by wearing slips and keeping records of the service rendered by each slip. Twenty-two of the subjects were teachers and two were secretaries in school offices. Slips ranging in size from 29½ to 38 were required.

Eighteen of the wearers considered themselves easy on clothing, while six, because of their size, activities engaged in, or general manner of movement, felt they were hard on clothing. Fifteen moved deliberately and nine quickly. Cars were driven by 11. Only three engaged in other activities which caused them to feel clothing wear might be affected.

The service given by different slips seemed to hold a direct relationship to the activity of the wearer and to whether she was hard or easy on clothing. One of the wearers of slip A, and one of slip B, considered themselves hard on clothing and were particularly active. The effect of wear due to activity was evident on their slips, which were worn fewer hours than the remaining slips in the same groups. The size of the subject also

affected the wear of the slip, but it would seem to have less effect than activity. Referring to the same wearer of slip A, a smaller size was required for her than for two others of the same group; lack of service was due to her manner of movement and activity. The slip worn by the subject requiring the largest size in Group A showed less sign of wear than the other three slips.

Eight of the wearers indicated that they perspired freely while all except one used either an astringent or deodorant. Examination of the slips after they were retired from service showed no appreciable effect because of perspiration or the attempt to check it. Table 2 gives information concerning the wearers.

Results of Fabric Analysis

Microscopic analysis of the fabrics indicated that, with the exception of one slip, yarns used in both the warp and filling were of viscose rayon. In slip A the warp yarns were acetate and the filling were viscose. The results of fabric analysis appear in Table 3.

Among the viscose fabrics studied, the thread count ranged from 72 to 113 threads in the warp and from 49 to 85 in the filling. Three of the slips showed a similar

Table 2. Information concerning the wearer, her occupation, size and habits that might affect the wear given each slip.

Slip	Occupation	Size slip	Bust	Hip	Weight	Movements: quick	Movements: deliberate	Activities that affect wear: drive car	Activities that affect wear: others	Hard or easy on clothing	Where slips first show wear	Perspire freely	Use astringent or deodorant
A1	teacher	38	36	40	145		x	yes	no	easy	back	no	yes
A2	teacher	36	36	39	137		x	yes	no	easy	seat	no	yes
A3	teacher	34	33	37	120	x		yes	active	hard	straps	no	yes
A4	teacher	32	32	36	112	x		yes	no	easy	back	no	yes
B1	teacher	38	37	41	142	x		no	active	hard	underarm	yes	yes
B2	teacher	36	36	38	133	x		yes	no	easy	straps	no	no
B3	teacher	31½	30	36	108		x	yes	no	easy	seams	yes	yes
B4	teacher	29½	30	35	106	x		no	no	easy	seat	yes	yes
C1	teacher	38	36	43	150	x		no	no	hard	straps	yes	yes
C2	secretary	36	36	40	144	x		yes	no	easy	back	no	yes
C3	teacher	34	32	39	110	x		no	no	hard	seams	yes	yes
C4	secretary	32	32	37	120		x	no	active	easy	seat	no	yes
D1	teacher	38	38	43	160		x	yes	no	easy	underarm	no	yes
D2	teacher	34	31	38	114		x	no	no	easy	seams	no	yes
D3	teacher	34	34	39	138		x	yes	no	easy	top	no	yes
D4	teacher	32	32	36	115	x		no	no	easy	seams	no	yes
E1	teacher	38	41	44	167		x	yes	no	hard	seat	yes	yes
E2	teacher	36	36	40	150		x	no	no	easy	across knees	no	yes
E3	teacher	36	35	39	157		x	no	no	easy	seat	no	yes
E4	teacher	34	33	37	120		x	no	no	easy	left side	no	yes
F1	teacher	36	36	39	127		x	no	no	easy	underarm	yes	yes
F2	teacher	36	34	39	130		x	no	no	hard	seat	no	yes
F3	teacher	36	35	37	132		x	yes	no	easy	underarm	yes	yes
F4	teacher	34	33	35	117		x	no	no	easy	strap	yes	yes

Table 3. Fabric analysis of the six control slips.

(A) Fiber content, thread count, breaking strength, and elongation.

Slip	Fiber		Thread count per inch		Breaking strength in pounds		Elongation in inches		Elongation in percentage	
	warp	filling	warp	filling	warp	filling	warp	filling	warp	filling
A	acetate	viscose	156	106	19.4	22.6	0.69	0.71	23.0	24.0
B	viscose	viscose	113	85	29.8	33.3	0.63	0.78	21.0	26.0
C	viscose	viscose	96	71	28.1	31.2	0.41	0.55	13.6	18.3
D	viscose	viscose	96	66	26.0	25.1	0.47	0.41	15.6	14.0
E	viscose	viscose	91	60	24.7	14.1	0.34	0.35	11.3	11.6
F	viscose	viscose	72	49	24.4	17.3	0.53	0.56	17.6	18.6

(B) Yarn twist, thickness, weight per square yard, percentage of sizing, seam slippage and percentage of shrinkage.

Slip	Yarn twist per inch		Thickness in inches	Weight per sq.yd. in oz.	Percentage of sizing	Seam slippage in lbs.	Percentage of shrinkage per yd.	
	warp	filling					warp	filling
A	3.1	36.4	0.0079	2.7	1.0	no slippage	10.3	2.2
B	6.3	26.6	0.0086	3.4	0.5	no slippage	9.9	0.8
C	4.6	4.1	0.0060	2.5	1.8	no slippage	5.7	0.5
D	3.4	2.5	0.0065	2.5	2.3	no slippage	4.4	*1.7
E	4.2	3.9	0.0036	1.9	5.1	7	3.8	0.8
F	2.6	2.4	0.0042	2.1	0.5	6	4.1	0.8

*stretch

count in the warp. Slip B, which was considered the most serviceable, indicated the highest thread count both warpwise and fillingwise and was the most nearly balanced. The slip giving least service had the lowest thread count. The slip of acetate viscose yarn showed the highest thread count in both warp and filling, that is, 106 to 156 yarns. However, this slip did not give satisfactory service because of other factors.

The yarns of all fabrics studied has a Z twist. Slips A and B showed a much higher twist in the filling yarns than any of the other fabrics, with a count of 36.4 in one and 26.6 in the other. These were the only fabrics having the highest twist in the filling. Twist in the other filling yarns varied from 2.4 to 4.1 and averaged 3.2. The variation in the warp was 2.6 to 6.3, with an average of 4.3. Slip F which showed the most serious raveling had only 2.6 twists per inch warpwise, and 2.4 fillingwise.

The breaking strength of three fabrics was greater on the filling than on the warp. The high twist in the filling of two of these may account for the higher breakage. The third averaged about the same in twist both warpwise and fillingwise. The three fibers having the higher strength in the warp also had a higher percentage of warp

threads than filling as compared with the other fabrics. The breaking strength of four of the fabrics warpwise and fillingwise was more nearly balanced than for the other two. Warp breaking strength varied from 19.4 to 29.8 pounds and averaged 26.4 pounds. The acetate yarns showed the lowest strength in this group. The filling ranged from 14.1 pounds to 33.3 with an average of 25.9 pounds.

Fabrics which were wet lost strength in amounts varying from 45.4 to 66.8 percent in the warp and from 36.7 to 69.3 percent in the filling. The acetate warp yarns tended to have a lower percentage loss than the viscose warp. Smith (14) reported that the affinity of acetate yarn for moisture was less sensitive than that of viscose, and its breaking strength while wet was less affected. The two viscose fabrics having the high twist in the filling were also least affected and had a lower percentage loss.

Preliminary tests indicated that the slippage of the warp on the filling threads was greater than the slippage of filling on the warp. However, only two of the fabrics tested showed slippage to any extent. One indicated slippage at six pounds, the second at seven pounds. According to Simon (13), if resistance to slippage is less than 10

pounds, trouble is likely to occur and serviceability is doubtful, while with a resistance of over 20 pounds, there is little possibility of complaint. The two fabrics showing slippage were also low in thread count, breaking strength, and twist.

There was noticeable variation in the amount of shrinkage of the different fabrics. They shrank warpwise in percentages varying from 3.8 percent to 10.3 percent, with an average of 6.4 percent. The filling averaged 0.9 percent and ranged from 0.5 to 2.2 percent. One fabric tended to stretch 1.7 percent.

The thickness of the materials varied from 0.0036 to 0.0086 inches. There seemed to be no indication that thickness affected in any way the serviceability of the slip.

Weight per square yard ranged from 1.9 to 3.4 ounces per square yard. In most cases the service rendered by the fabric varied directly with the weight of the material.

The success of rayon weaving and the rapidity with which rayon fabrics can be woven depend first upon the use of a suitable warp sizing solution and on the proper impregnation of the rayon yarns (5). Sizing in most cases is used to prevent abrasion of warp thread during the

weaving process. Rayon fabrics are never tin weighted or loaded with metallic salts (6). The amount of sizing found in the fabrics was low, ranging from 5.1 to 0.5 percent. No qualitative analyses were made. There seemed to be no agreement between the amount of sizing used and the serviceability of the garment. The slip rendering the least service and the one giving the most satisfactory wear had the lowest amounts.

The breaking strength of three of the abraded samples was higher on the filling than on the warp, while with the three remaining specimens the reverse was true. In this respect there was agreement with the breaking strength of the controls and, with the exception of one group, the worn slips. The slip giving the best service showed the least effect of abrasion and was the only one in which breaking strength of warp and filling yarns was nearly balanced. The variation in the warp was from 5.4 to 27.7 pounds and in the filling, from 0.8 to 28.0 pounds.

There was little or no loss in breaking strength due to aging. In the warp the percentage varied from -4.5 to 47.5 percent, while in the filling the percentage ranged from -6.9 to -0.1 percent.

None of the worn slips showed an extremely low break-strength except the acetate warp yarns in slip A. The percentage loss in the warp was 16.8 to 58.4. The percentage loss in the filling was 4.0 to 50.4. Four of the groups retained a higher breaking strength in the filling than in the warp. Three of these were nearly balanced in the warp and filling. The serviceability record of worn slips is shown in Table 4.

Elongation ranged from 0.34 to 0.69 inch for the warp and from 0.35 to 0.78 for the filling. Elongation was highest in the warp in the one slip made of fabric that was acetate warpwise. Acetate seemingly permitted of greater elongation than viscose yarns. Among the slips that were made of all-viscose yarn the one giving most satisfactory wear showed greatest elongation in the warp and filling.

The breaking strength and elongation of dry control, wet, aged, abraded, and worn fabrics are shown in Tables 5 and 6.

Table 4. Serviceability record of 24 worn rayon slips.

Slip	First evidence of wear: Hours wear	First evidence of wear: Where	Hole appears: Hours wear	Hole appears: Where	Pulled area appears: Hours wear	Pulled area appears: Where	Tear appears: Hours wear	Tear appears: Where	Straps resewed: Hours wear	Resewed repair: Hours wear	Resewed repair: Where	Total hours worn	Launderings: Total times	Launderings: Av. no. hrs. between
A1	250	yoke	300	yoke	500	back	1500	hem	-	529	back	1669	49	34
A2	295	yoke	500	yoke	1000	waist	1500	back	1000	1000	strap	1506	37	41
A3	166	yoke	166	yoke	218	seat	460	back	769	460	back	1500	36	42
A4	200	yoke	240	yoke	600	back	1500	back	1500	1500	strap	1550	26	60
B1	300	back	300	back	-	-	-	-	2172	300	back	2240	28	80
B2	1000	yoke	2500	yoke	-	-	-	-	2340	1775	hem	2500	41	61
B3	500	yoke	2300	yoke	-	-	-	-	500	500	strap	2500	45	56
B4	1000	yoke	2500	yoke	-	-	-	-	-	-	-	2519	44	57
C1	871	strap	1000	yoke	-	-	-	-	871	871	strap	1343	24	56
C2	111	strap	1500	yoke	-	-	1338	yoke	111	111	strap	2000	21	95
C3	69	seam	1500	yoke	69	seam	-	-	225	225	strap	2000	38	52
C4	366	back	366	seat	-	-	-	-	1200	1200	strap	2000	41	49
D1	850	yoke	1800	under arm	850	seam	-	-	-	1000	yoke	1889	39	64
D2	81	strap	-	-	500	seam	-	-	81	81	strap	2003	26	77
D3	319	strap	1500	panel	1000	seam	-	-	319	319	strap	1769	34	52
D4	500	yoke	-	-	1000	seam	-	-	551	551	strap	2513	32	78
E1	129	yoke	-	-	1000	panel	-	-	1500	500	back	1525	68	22
E2	500	strap	-	-	1000	panel	-	-	552	552	strap	1593	43	37
E3	40	back	-	-	40	back	-	-	-	867	back	1500	36	44
E4	1000	strap	-	-	1000	panel	-	-	-	1550	seam	1797	43	42
F1	270	seam	-	-	270	seam	-	-	-	435	seam	1317	23	57
F2	55	seam	-	-	55	seam	-	-	-	55	seam	1273	61	21
F3	56	seam	-	-	56	seat	-	-	71	114	seam	1124	20	62
F4	27	seam	-	-	27	seat	-	-	-	114	seam	1267	24	53

Table 5. Average breaking strength of new, wet, aged, and abraded fabrics of six control slips and average breaking strength of worn rayon slips.

Slip	Breaking strength in pounds					Percentage change in breaking strength			
	new	wet	aged	abraded	worn	wet	aged	abraded	worn
			Warp				Warp		
A	19.4±0.3	10.6±0.2	18.5±0.7	6.2±6.0	8.1±0.7	-45.4	-4.5	-68.1	-58.4
B	29.8±0.2	9.9±0.5	31.0±0.1	27.7±0.7	23.2±0.9	-66.8	+4.0	-7.1	-22.0
C	28.1±0.6	10.0±0.6	29.7±0.3	9.5±2.0	21.6±0.7	-64.4	+5.9	-66.5	-23.0
D	26.0±0.5	10.0±0.6	25.2±0.8	15.0±0.2	19.5±0.8	-61.6	-2.8	-42.3	-25.0
E	24.7±0.4	10.7±0.4	26.6±0.3	16.9±0.2	19.1±0.8	-56.3	+7.5	-31.5	-22.6
F	24.4±0.4	10.2±0.1	24.0±0.1	5.4±0.1	20.3±0.7	-58.6	-1.5	-77.8	-16.8
			Filling				Filling		
A	22.6±0.5	14.3±0.3	22.4±0.1	20.2±0.8	21.3±0.3	-36.7	-0.1	-9.7	-5.5
B	33.3±0.3	18.4±0.6	33.2±0.3	28.0±1.0	31.9±0.4	-44.7	-0.3	-15.9	-4.0
C	31.2±0.6	11.2±0.3	30.7±0.6	26.5±0.4	22.1±0.4	-64.1	-1.6	-14.8	-29.0
D	25.1±0.1	9.2±0.6	24.7±0.1	10.0±0.4	21.5±0.2	-63.3	-1.8	-60.1	-14.4
E	14.1±0.6	6.6±0.1	13.7±0.3	0.8±0.2	10.3±0.3	-60.2	-2.6	-94.4	-27.0
F	17.3±0.6	5.3±0.2	16.1±0.4	2.3±0.3	8.6±0.3	-69.3	-6.9	-86.5	-50.4

Table 6. Average elongation of new, wet, aged, and abraded fabrics of control slips and average elongation of worn rayon slips.

Slip	Elongation in inches					Percentage variation in elongation from new control			
	new	wet	aged	abraded	worn	wet	aged	abraded	worn
				Warp				Warp	
A	0.69±.01	0.70±.03	0.54±.01	0.26±.05	0.32±.04	+0.1	-21.6	-62.3	-53.6
B	0.63±.03	0.54±.02	0.78±.01	0.74±.02	0.73±.04	-14.3	+23.7	+17.5	+17.4
C	0.41±.01	0.25±.01	0.46±.01	0.17±.03	0.41±.04	-38.9	+12.0	-58.5	0.0
D	0.47±.01	0.35±.02	0.50±.02	0.18±.03	0.43±.03	-21.0	+6.1	-61.7	-8.3
E	0.34±.01	0.31±.01	0.39±.01	0.35±.03	0.43±.03	-8.7	+15.1	+3.0	+26.8
F	0.53±.01	0.63±.01	0.56±.03	0.12±.01	0.55±.01	+19.0	+5.6	-77.3	+3.9
				Filling				Filling	
A	0.71±.01	0.63±.02	0.59±.01	0.48±.03	0.53±.03	-11.1	-26.7	-31.4	-25.2
B	0.78±.02	0.69±.03	0.78±.01	0.75±.04	0.69±.03	-11.6	0.0	-3.9	-11.4
C	0.55±.03	0.44±.02	0.58±.02	0.58±.01	0.48±.04	-12.0	+5.4	+5.1	-12.8
D	0.41±.01	0.34±.02	0.50±.02	0.14±.01	0.43±.02	-17.0	+22.0	-70.3	+5.0
E	0.35±.01	0.39±.01	0.46±.01	0.07±.01	0.40±.03	+11.5	+30.5	-98.0	+14.5
F	0.56±.03	0.54±.03	0.57±.02	0.12±.02	0.46±.04	-3.4	+7.3	-78.5	-16.4

Analysis of Worn Slips

The lack of satisfactory service rendered by the slips in Group A as compared to the other slips was due to the presence of cellulose acetate yarns in the warp of the fabric. After the first few hundred hours wear worn places and holes appeared near the seams of the yoke. Later, holes were noticed elsewhere, with all the acetate warp yarns worn away while the viscose filling remained. Evidence of this failure is shown in Figs. 11 and 12. These slips were retired from service after an average of 1556 hours wear and 37 launderings. They were definitely worn out and would no doubt have been discarded earlier had they been other than test slips. The breaking strength of the worn slips averaged 8.1 pounds in the warp, but 21.3 pounds in the filling. The latter was little less than the control. The figures for the breaking strength of abraded specimens compared closely with these. It is possible that the heavier viscose yarns with the higher twist caused considerable wear on the finer acetate yarns with little twist.

There was much less raveling along the seams of these slips than of the other which were also finished with the

EXPLANATION OF PLATE IV

Evidence of failure in slips made of fabrics in which viscose and acetate yarns are combined.

Fig. 11. The acetate yarns are worn away while the viscose filling yarns remain (from slip A).

Fig. 12. Wear along the seams of the yoke is extensive on a slip of fabric made of acetate and viscose yarns (from slip A).

PLATE IV

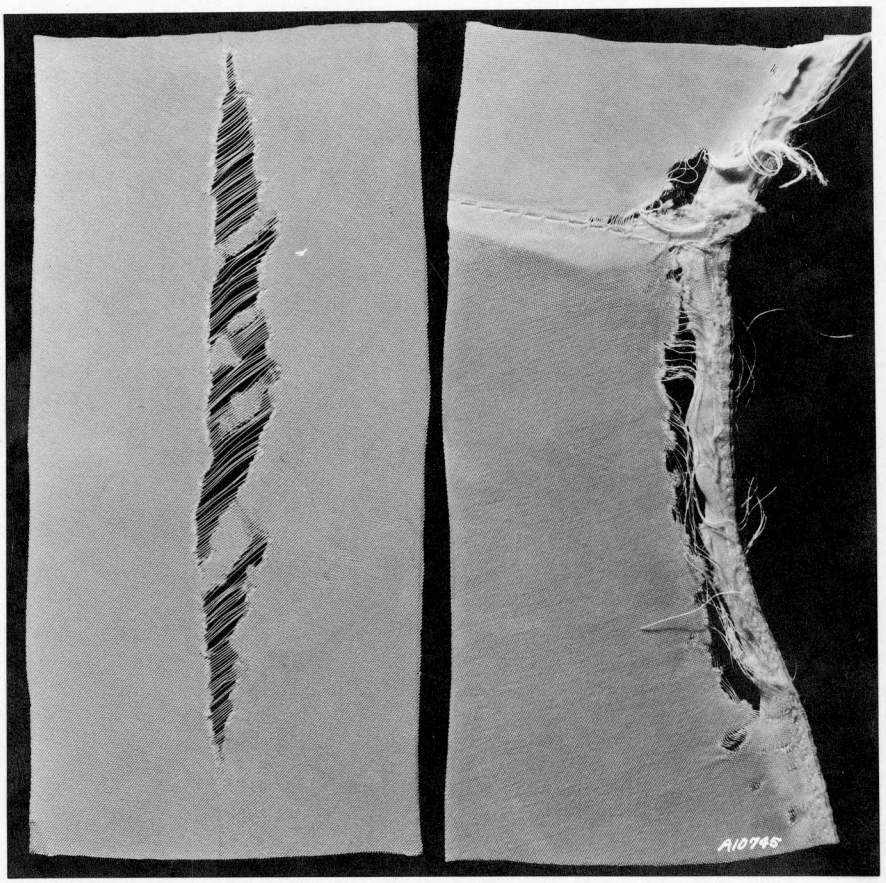

Fig. 11 Fig. 12

lapped seam but were made of viscose. The difference between the raveling of acetate and viscose fabrics was due probably to the fact that viscose rayon swells twice as much as acetate when wet with water (16). The seams of the acetate slips were stitched with the lock stitch and at no time showed any tendency to pull out. (Fig. 14).

Slip A was the highest priced slip purchased. It had the highest thread count, showing 43 more threads in the warp and 21 in the filling than the other qualities. However, the breaking strength was about average fillingwise and was the lowest of all warpwise. This indicated that high thread count does not always determine high breaking strength. The yarn twist was 36.4 turns in the filling as compared to an average of 6.6 in the remaining slips.

Wearers reported that the slips showed noticeable shrinkage. Test specimens of this fabric also indicated the highest shrinkage of all. This might be accounted for because of the high yarn twist in the filling yarns and since all fabrics of crepe construction shrink when wet. They should be eased back into shape when damp as they are ironed (8). No effort was made to do this with the samples.

The four slips in Group B were worn more hours, showed fewer signs of wear, and had a smaller percentage decrease in warp breaking strength at the end of the study than any other quality. Loss in breaking strength was only 4.0 percent in the warp and 22.0 in the filling.

Laboratory tests of the controls indicated that these slips should give the most satisfactory service. Comparing them with the others made of all viscose, the thread count was the most nearly balanced and was higher, with 17 more threads warpwise and 14 more fillingwise than Group C, or the second highest. Breaking strength was only slightly higher than Group C by 1.9 pounds in the warp and 2.1 in the filling, while the twist indicated 1.7 more turns warpwise and 22.1 fillingwise.

The service rendered by any group of slips and their appearance on the wrong side after being worn and laundered depended to a great extent upon the type of seam. Lapped seams with the lock stitch were used in the construction of this group. Probably because of the use of the lock stitch the seams showed no indication of separating after the garment had been worn an average of 2440 hours and laundered 39 times. However, the edges raveled to such an extent that the slips appeared worn and poorly finished

on the wrong side as is shown in Fig. 13. Near the end of the period of wear some of the machine stitches had begun to break (Fig. 16).

There were no raw edges showing on the slips in Group C. The yokes were double and stitched the same on each side. Fell seams held with plain machine stitching were used. This seemed to be a most satisfactory method of finishing, in that raveling could be prevented and no seam pulled out. However, the machine stitching broke in several places early in wear as is shown in Fig. 15. If this were not repaired, frayed edges soon appeared (Fig. 18).

Occasionally rayon wash materials have been designed in such a manner that considerable untwisted rayon yarn is thrown to the face of the fabric. Due to the lack of twist in the yarns used, together with the ordinary friction of wear, some of the individual filaments are broken, with the result that the fabric develops a linty appearance. This is described as chafing (8) and is shown in Fig. 17. The sample pictured was taken from slip C. Chafing also occurs in coarsely constructed rayon fabrics.

EXPLANATION OF PLATE V

Fig. 13. Viscose fabrics ravel extensively after laundry (from slip B).

Fig. 14. Acetate fabrics show less raveling due to characteristics of fabric (from slip A).

PLATE V

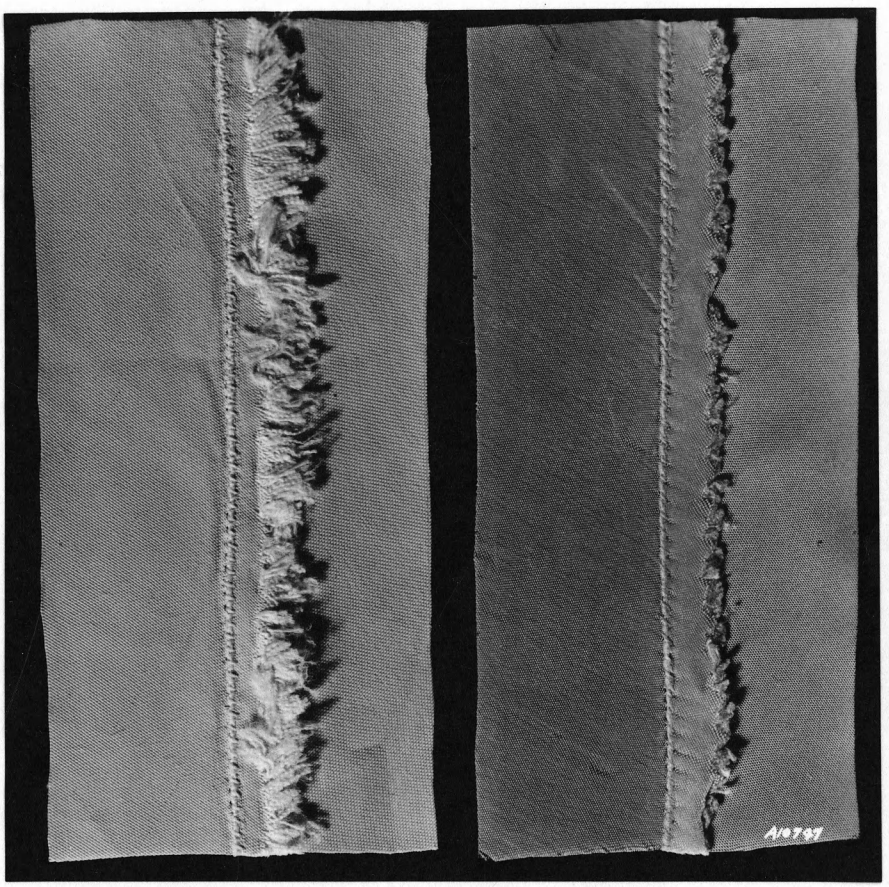

Fig. 13 Fig. 14

EXPLANATION OF PLATE VI

Fig. 15. Plain machine stitching broke early in wear on the fell seams (from slip E).

Fig. 16. After several hundred hours wear the lock stitch seemed to be worn away (from slip B).

PLATE VI

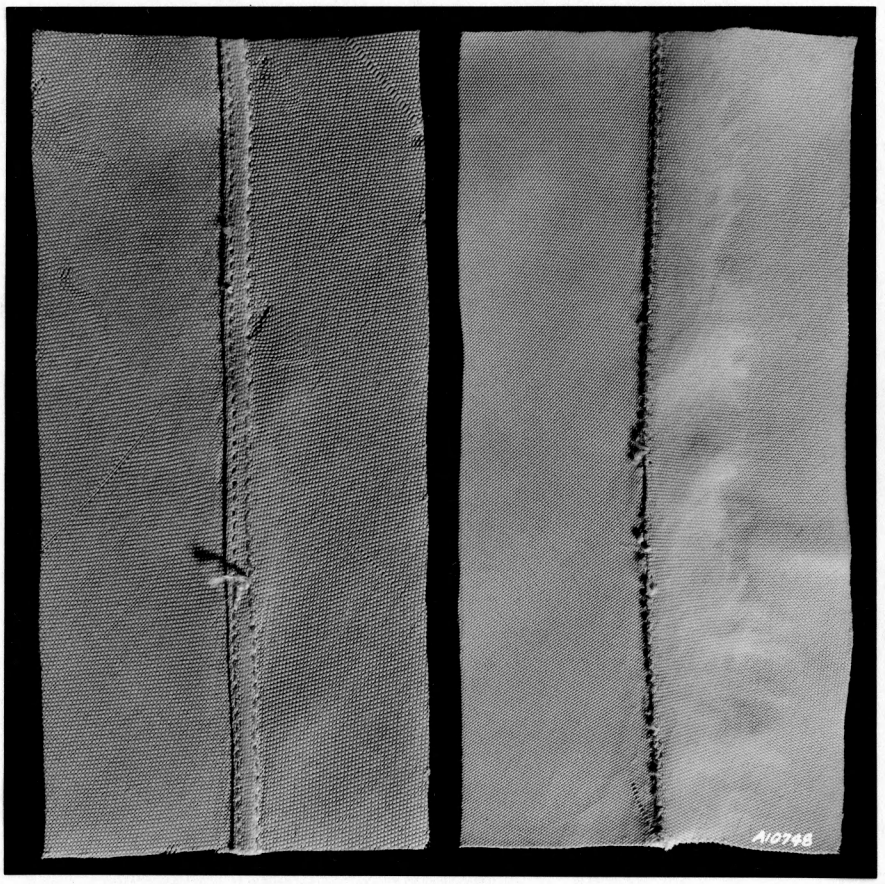

Fig. 15 Fig. 16

EXPLANATION OF PLATE VII

Fig. 17. Fuzzing or chafing is a common evidence of failure in coarsely woven viscose fabrics. The example of failure was taken from slip C. (2x)

PLATE VII

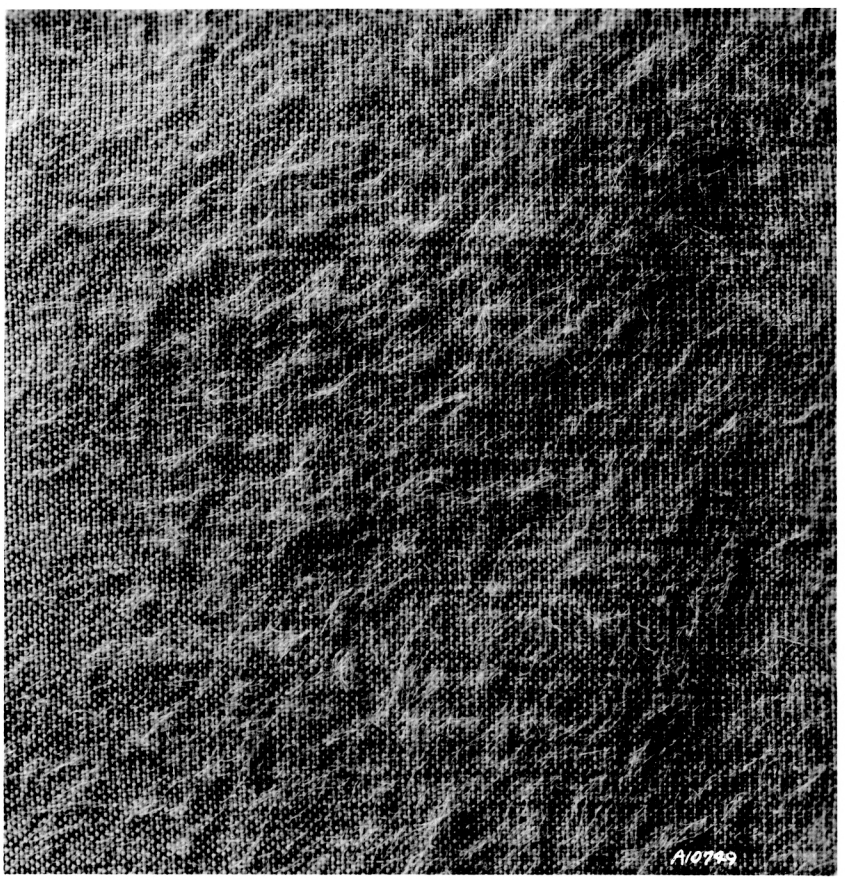

Fig. 17

Three of the slips were each worn 2000 hours. One wearer reported only 1345 hours wear because of difficulty in having it laundered as directed. They were the average price slip of those purchased, and were the only group made on the straight of the material. Satisfactory service was given by this slip as was predicted by laboratory tests. It was noticed that some of the slips of different groups seemed to absorb more dye from dark clothing and to change in color with wear and washing. This was particularly true of the ones in Group C.

Slips in Group D were the same price as those in Group C. While there was a noticeable difference in the construction and a slight difference in the results of laboratory tests, the service received from each was about the same. The slips in Group D averaged 2043 hours wear, although one was worn 2500 hours.

Slip D was cut on the bias and had only the single yoke in the back. The lapped seam was used and stitched twice, first on the wrong side then on the right with plain machine stitching. Here again there was considerable raveling of raw edges. No side seams pulled out but the back panel pulled away from the yoke after 500 to 1000 hours wear. These slips showed little discoloration due

to wear and laundering. They retained their color and seemed to absorb little dye.

There was the same number of warp yarns in Group D as in Group C, while the filling of Group D showed seven less. Breaking strength was 26.0 warpwise and 25.1 fillingwise on Group D as compared to 28.1 and 31.2 on slip C. The twist in the yarns of slip C was less by 1.2 turns per inch in the warp and 1.6 in the filling.

Analysis of the control fabrics indicated that only two groups of slips showed slippage to such an extent that trouble was likely to occur. These two were Groups E and F. Both might be considered low priced slips.

The type of seams used on the slips of Group E apparently added greatly to the wear of the garments. Tests of the control fabric, as compared with the qualities of the other viscose fabrics, indicated slip E to be second to lowest in thread count and in warpwise breaking strength, and lowest in fillingwise breaking strength. All other viscose fabrics were higher in elongation, thickness in inches, and weight per square yard. The percentage of sizing in slip E was 5.1 while the other slips ranged from 0.5 to 2.3 percent. In comparing the fabric of this slip with the control viscose fabric which had the highest

result in each test, thread count showed 22 fewer threads warpwise and 25 fillingwise. The breaking strength was lower, 5.1 pounds in the warp and 19.2 in the filling. The elongation was lower by 0.32 inch warpwise and 0.43 fillingwise. Thickness in inches was lower by 0.005 and weight per square yard by 1.5 ounces.

Perkins (9) stated that usually the cheaper seam is used with the low priced garment, but some manufacturers will use a relatively cheap fabric and the more expensive construction. This seemed to be true with slip E. The garments were constructed with the fell seam and plain machine stitching. Yokes were double in both front and back and finished the same on each side. In no case did any side seams pull out, although after the first few hundred hours wear there was noticeable yarn slippage and the material appeared quite thin. Occasionally the machine stitching along the seams broke and it was necessary to restitch to prevent raveling. The back panels pulled away from the yokes very early in wear on some slips and repair was necessary.

This group was worn an average of 1604 hours and laundered an average of 48 times. Wearers considered the slips as giving satisfactory service, especially for wear

under heavier clothing. The loss of sizing left a thin fabric. They retained a good color and were easily laundered. There were objections to the use of elastic in the straps because of its discoloration and loss of elasticity before the slip was worn out. The fabrics also showed much chafing.

Wearers expressed little satisfaction with the service rendered by the slips in Group F. Dissatisfaction and the discarding of slips were due to the poor type of seam and stitching used in construction.

The seams were lapped and held with plain machine stitching. After the first few launderings the raw edges began to ravel and continued to ravel to such an extent that the seams separated as is shown in Fig. 19. There was no case of the seam pulling out with the raw edges remaining intact. Failure at the seam was due to complete raveling of the material forming the seam.

Seam repair was required on all four slips after 55 to 114 hours wear. After that, frequent repair was necessary and ordinarily the slips would have been retired from service with a few hundred hours wear. However, an attempt was being made to secure results of the effect of wear upon the fabric. They were finally discarded after

EXPLANATION OF PLATE VIII

Fig. 18. The fell seam raveled after the plain machine stitching had broken and was not repaired (from slip C).

Fig. 19. The edge raveled to such an extent that the seam no longer held (from slip F).

PLATE VIII

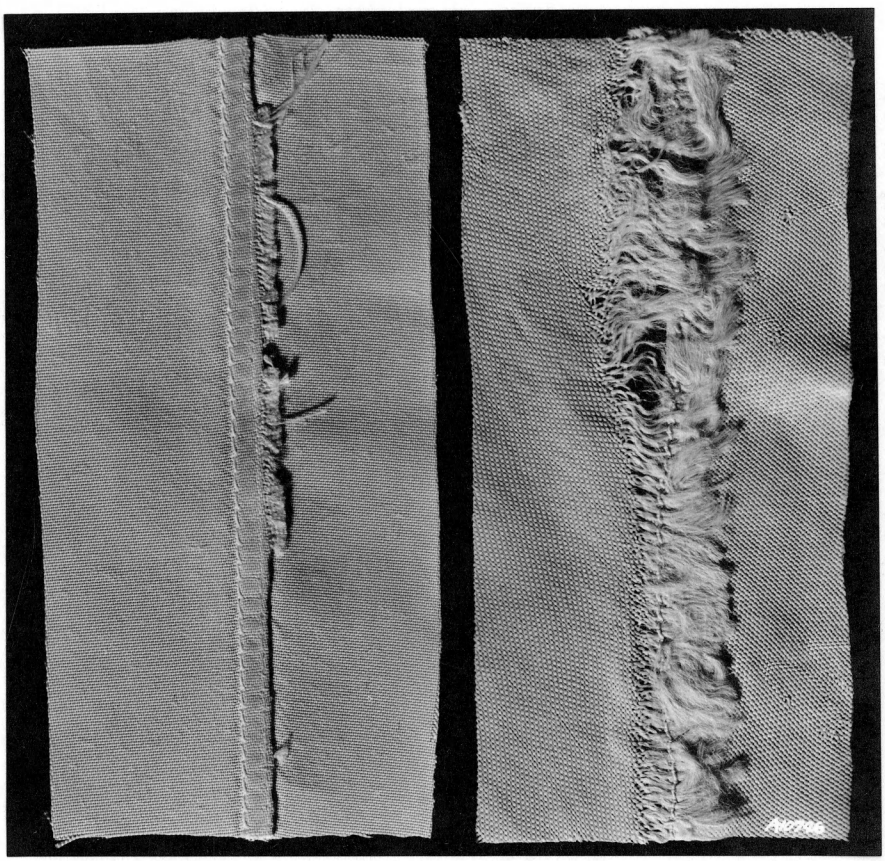

Fig. 18 Fig. 19

an average of 1273 hours wear. By then the fabric showed much yarn slippage and chafing. Tests of worn fabrics indicated that the warp had lost 20.3 percent in breaking strength, which was about average, but 50.4 percent in the filling, which was the highest of any.

These were the lowest priced slips purchased, costing $0.20 less than the one next in price and $1.14 less than the most expensive viscose slip. The thread count and twist were lower than the other qualities, with 72 threads warpwise and 49 fillingwise; twist was 2.6 by 2.4. In other tests they ranked higher than slip E, with the exception of warp breaking strength, which showed only 0.3 pound difference.

In the study of both Groups E and F, wear tests were probably more accurate in ascertaining amount of service than laboratory tests.

The following comparison of serviceability and cost of the slips was based upon reports and comments of the wearers and upon the appearance of the garment when checked at the end of each 500 hours wear and again when retired from service. In this comparison it was decided to consider the slip worn out when it would be no longer worn by this particular group of subjects during business hours.

Unsatisfactory appearance or necessity of frequent repair was the reason for discarding.

With the above standard as a basis for calculation, slip A should have been retired at approximately 1000 hours wear; slip B, 2500; slips C and D, 1750; slip E, 1500; and slip F, 500. The retail price of each was: slip A, $1.69; slip B, $1.65; slips C and D, $0.98; slip E, $0.79; and slip F, $0.59. Since 2500 hours was the greatest number of hours any group was wearable the following costs were calculated per 2500 hours of wear in this manner. For example, slip A should have been retired after approximately 1000 hours wear. If this make of slip were worn, 2.5 slips would be required to serve 2500 hours wear. This would make the total cost for that service $1.69 times 2.5 slips or $4.23. If slip F were worn, 5 slips would be required and the cost for 2500 hours wear would be $0.59 times 5 slips, or $2.95. On this basis slip A would cost $4.23; slip B, $1.65; slips C and D, $1.40; slip E, $1.32; and slip F, $2.95. However, this does not take into consideration the appearance of the garment when new, the fit, the repairs required, and the actual satisfaction it would give to the wearer because of certain characteristics.

CONCLUSIONS

The results of a study of the serviceability of certain ready-made rayon garments indicate that

A slip of all viscose gives better service than one of viscose and acetate.

The higher the thread count and the more nearly balanced the warp and filling yarns in viscose fabrics the greater the service that may be expected from the slip.

Serviceability is dependent upon the type of seam and stitches used, as well as the fiber and the construction of the fabric.

The use of the fell seam insures better appearance of a viscose slip after it has been worn and laundered. It adds to both the serviceability and appearance of a low priced slip. The use of the lapped seam held with lock stitching will give satisfactory wear on a slip made of fabric of higher thread count and twist, although it does not appear as neat on the wrong side after laundry and wear.

The wear given a slip seems to vary directly with the activity of the wearer, and to some extent with the size of the wearer.

The advisability of buying a low priced rayon slip

may be questioned, due to construction of the garment and the type of fabrics used.

ACKNOWLEDGMENT

Appreciation is expressed to Professor Alpha Latzke for directing this study and to Dr. Hazel Fletcher for valuable suggestions.

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APPENDIX

Form A

Directions for Wearing and Laundering Slips

Return the slip to the investigator at the end of each 500 hours wear. It is possible it may be worn 2000 hours or more. Keep the slip in as constant wear as possible, leaving only a minimum length of time for laundering.

If a hole appears in the garment, return with the record at once. The only alteration that may be made on the slip is to shorten it at the hem. Repairs may be made as sewing on straps, or sewing seams.

Laundry method: Use a suds of "Dreft" and luke-warm water. Temperature of water should not exceed 100 degrees F. The garment should be squeezed through the suds and not be twisted or wrung. Rinse in luke-warm water until no trace of suds appears. Roll the slip in a towel to absorb the moisture. Allow it to remain for ten minutes, then hang over a clothes hanger for ten minutes before ironing. Do not place near intense heat. If it is not convenient to carry out this method, dry the garment, then dip in water and roll in towel as directed. Iron in the direction of the thread on the wrong side with a warm iron of a temperature under 300 degrees F.

Form B

Concerning the Wearer of the Slip

and the Service Record of the Garment

Name of wearer_____

Address of wearer_____

Main occupation of wearer_____

Height of wearer ____ft.____in. weight _____lbs.

Bust measurement____in. hip measurement_____in.

Age: Under 25_____ Over 25_____

Do you move quickly ____ or deliberately _____?

Do you consider that you are hard____ or easy____ on your clothing?

Do you drive a car a great deal? Yes____ No____

Do you have any other activity which will affect the durability of a slip? Yes____ What_____ No_____

Where do your slips wear out first?_____

Do you perspire freely? Yes____ No____

Do you use an astringent? Yes____What _____ No_____

Do you use a deodorant? Yes____ Where_____ No_____

Has the slip been scorched? Yes____Where _____ No_____

Pulled areas noticed after ____hours wearing and ____ launderings.

Where _____

Hole noticed after ____hours wearing and ___ launderings.

Where_____

Tear noticed after ____hours wearing and ___ launderings.

Where _____

Straps needed fastening after ____hours wearings and ____ launderings.

Repair needed after _____hours wearing and ____launderings.

How_____

Thin spot noticed after _____hours wearing and ____ launderings.

Where_____

Form C

Time Record

Name ____________________ Address __________________

Date	No. hrs. worn each day	Times worn	Times laundered	Remarks