EFFECT OF STITCH LENGTH AND TYPE OF THREAD ON THE STRENGTH OF SEAMS IN WOOL AND WOOL-LIKE FABRICS

by

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CHAPTER I

INTRODUCTION

The strength of seams in garments is influenced by many factors, including quality of fabric and thread, size of stitch and number of stitchings, kind and width of seams and direction of the seam in relation to the warp and filling yarns of the fabric. According to Federal Standards number DDD-S-751 (20), a seam should be of sufficient strength to withstand the strain to which it will be subjected in the use and wear of the garment of which it is a part. The standard lists the following factors as affecting seam strength; type of stitch, combination of threads, number of stitches per inch, and the tightness and construction of the seam. The standard further states, "The seam should be durable, look well and have a certain degree of elasticity."

Seams are the structural lines of a garment. They are used to join variously shaped pieces of fabric to give the style and shape of garment you want. There are several kinds of seams, but by far the most versatile and widely used is the plain seam. Other seams used in particular situations are the lapped seam, French seam, and flat felled seam. According to Lewis (10), the plain seam is made simply by stitching two edges of cloth together, it is versatile and widely used; the lapped seam is used where oddly shaped pieces are to fit together with top stitching, it is not as strong as some other types of seams; the French seam is used on sheer fabrics where wide seam edges would show through unattractively, French seams are strong and completely free of ravelings; and the flat felled seam is a strong, flat tailored seam with no raw edges, it is used on sports clothes and wherever durability or comfort is the chief concern. The type of seam to be used in garment construction depends upon a number of factors: (1) the desired durability, (2) closeness of weave in the fabric, (3) necessary comfort, (4) location of the seam, and (5) appearance of the finished seam.

In the last few years there has been a marked increase in the amount of sewing done in the home. Mrs. Mildred Ryan, in a talk given at the American Home Economics Association's national convention, June 1963, (12) said, "Today five million teen agers sew, using fifty-eight million yards of fabric and constructing twenty-two and one-half million garments each year." It is felt by Mrs. Ryan however, that the increase in home sewing has not kept pace with the population increase.

Anreder, in Barron's National Business and Financial Weekly (2), gives figures to show the increased sales of sewing machines in the United States since 1951. This was when foreign manufacturers invaded the United States with lower priced but improved machines. The flood of foreign imports caused some temporary hardship for domestic concerns but it by no means brought disaster. In a vastly expanded market new opportunities have opened up for investment and the future looks bright. Today automatic stitch devices, wider and longer feed dogs, free arms and many other model changes in the sewing machine business are becoming as frequent as in the auto industry.

In a survey prepared for Simplicity Pattern Company (17) in 1955, on the development of the home sewing market and its future, the following figures are given; thirty-eight million women in the United States sew creatively, in 1953 these women spent a total of 834 million dollars on patterns, notions, sewing machines and fabrics. Pattern and piece goods sales have doubled since 1939, and this survey claims that the home sewing trend is growing faster than the female population having increased twelve per cent since 1940. A more recent survey done by the Bureau of Industrial Service, with the aid of the Singer Sewing Machine Company (21), states that forty million women sew creatively making home sewing America's favorite hobby. Of these women, twenty-eight million make dresses, twenty-six million five hundred thousand children's clothes, almost twenty-two million blouses, eight million tailor suits and over five million coats. In addition, twenty-nine million American women like to sew their own draperies and curtains and about eleven and one-half million make slip covers. This study sweeps away the time-worn impression that a substantial share of sewing machine users turn to their sewing machines for only darning and mending. The actual fact is that only two per cent of them fall into this class and they are not included in the forty million figure of creative home sewers.

One of the factors that has inspired the surge to "make-it-yourself" has been the increase of lovely fabrics on the market today. The fabrics of today have changed considerably from those of twenty years ago, ten years ago, or even five years ago. Shelden (14) says, "It is a well-recognized fact that new fibers, and the new finishes have given rise to a wide variety of fabrics unknown to our grandmothers and mothers."

Both in fabrics and in sewing threads, research has been done and new products developed for the consumer market. One recent idea has been to change the shape of man-made filaments so that they are no longer round, this causes the resulting fabric to have a whole new set of properties. Man has also been able to crimp, curl, stretch and flatten the filament yarns so that they will resemble natural fibers in appearance and properties. Frequently the characteristics of two or more fiber types, man-made or natural, are combined by blending or mixing of two or more fibers together. Several types of synthetic threads have also been developed and are sold for use by the home sewer. One of the most recent to come on the market has been a textured nylon thread.

In using these new fabrics and threads many problems arise -- problems which one is at a loss to handle. Continued research is needed in construction techniques, cleaning methods, and the question of what one can expect from the cloth. New products cannot be used to the best advantage until they have been studied and testing has been done to determine the limitations and advantages of these products.

A few of the numerous and varied problems evolved by these advances in fabrics are, the number of stitches used in the construction of the seam, the type of thread to be used, and the kind of seam to be constructed. All of these affect the durability and appearance of the seam. Examination of ready made garments of wool and wool-like fabrics showed that the average number of stitches per inch was nine. Higher priced garments had a slightly higher number of stitches. Home sewers are advised to consider carefully the number of stitches per inch according to the weight of the fabric under construction. Lewis (10), a Wool Bureau Bulletin (9), and an educational publication of the American Viscose Corporation (7), have charts which suggest the correct stitch size for various types of fabric.

In helping home sewers formulate standards of construction, type of thread, type of seam, and the number of stitches per inch must all be considered. The purpose of this study was to ascertain the relative strength of a plain seam and a flat felled seam as controlled by certain variables: (1) fabric, (2) number of stitches per inch, (3) type of thread, and to compare the strength of the two seams in relation to lengthwise, crosswise, and off-grain directions of the fabric. It is hoped that such a study will be of value to the home sewer, teacher, and student in choosing construction techniques best suited to the kind of fabric and desired durability.

CHAPTER II

REVIEW OF LITERATURE

The literature reviewed revealed that little research has been conducted in the study of seams used in the construction of garments made in the home.

In 1960, Coon (5), undertook to determine the strength of seams as they were influenced by stitch length, thread, and type of fabric. In this study three wash and wear cotton fabrics were analyzed using two types of seams, two types of cotton thread and two stitch lengths. The relation of the variables with each other showed that fabric strength in relation to the type of thread was significant on the felled seam but showed no significance on the plain seam.

The number of stitches per inch in relation to fabric strength showed a significance on both types of seams as did the fabric strength in relation to grainline direction. In general, the off-grain and filling-wise seams showed the greater strength, perhaps due to the greater strength of the warp yarns. The plain seam was stronger warp-wise when stitched with nine stitches per inch than with fifteen. However, with off-grain and filling-wise seams, fifteen stitches per inch showed greater strength than nine.

The United States Bureau of Human Nutrition and Home Economics in cooperation with the Ohio State University and the Ohio Agriculture Experiment Station (22), conducted research on seams of cotton housework dresses. Other areas of this study included patch pockets and button-holes. To obtain basic information on the effect of fabric, number of stitches per inch and type of thread, breaking strength and elongation research was conducted.

As part of the study, fabrics were analyzed for weight per square yard, thickness, and thread count. The properties of the sewing thread were also studied.

The results of this study indicate that the direction of the seam in relation to the warp and filling yarns had the greatest influence on breaking strength. In general flat felled seams were the strongest of those studied, the degree of their superiority was influenced by the position of the warp and the filling yarns to the seam. The plain seam, the lapped seam, and the French seam were not significantly different in strength. The standing fell seams were somewhat weaker because of the tendency of the narrow edge of the seam to pull away from the stitching.

Other factors that influenced the strength of the seams in order of their importance were length of stitch and kind of thread. Apparently the size of the stitch had more effect on seams where the warp yarns or both the warp and filling yarns bore the strain than those where the filling yarns alone bore the strain. The distribution of breaking strengths of seams made with stitches of various sizes reveals the influence of the size of the stitch. In most cases, the higher breaking strengths were associated with the higher number of stitches per inch.

Seams were stitched with 2-cord 00 mercerized threads, 3-cord mercerized size 50, and 6-cord unmercerized size 50, which seemed to be slightly the strongest of the three. Approximately twenty-five per cent of the tests showed significant differences in seam strength associated with the kind of thread used. Final results of the research showed that washing rather than wear causes seam and seam finish deterioration.

A DuPont bulletin (8) pertaining to sewing on fabrics made of man-made fibers, reports that the home sewer will find that modifications in thread, tension, pressure on the pressure foot and stitch length, are required for best results in sewing on fabrics made of man-made fibers. Threads of nylon and Dacron polyester are recommended because they blend most effectively with fabrics containing these man-made fibers and result in stronger more durable seams. Basting is suggested to prevent shifting of the fabric during handling, especially when the fabric is fed through the sewing machine. For most fabrics twelve to fifteen stitches per inch are considered most satisfactory. This bulletin suggests applying a little tension to the fabric, behind and in front of the needle when stitching to prevent puckering. Sewing at a moderate, even pace with few stops and starts is considered best. Fabrics of synthetic fibers require lower thread tension than those customarily used with other fabrics. Because threads of man-made fibers are often stronger than those made of natural fibers it may be more difficult to test the balance of the machine stitch. The type of seam and seam finish should be chosen to suit the fabric weight and the type of garment being constructed.

A pamphlet of the American Viscose Corporation (7), on the subject of sewing on rayon suggests that a knowledge of the fabric is important to the home sewer if professional results are desired. In this pamphlet mercerized sewing thread is recommended for most rayon fabrics. The home sewer must be sure to use correct sizes in needles and thread for the fabric she is using. Fourteen stitches per inch for fabrics such as rayon gabardine, twill, serge and flannel are suggested. Attention to these points will result in inconspicuous lines of stitching, and seams that will stand up well without pulling the fabric.

Successful Sewing with Wash and Wear Fabrics, a leaflet issued by the Educational Bureau of Coats and Clark Inc. (16), states that because wash and wear fabrics, made of man-made fibers, are contributing constantly to the comfort and good looks of more and more garments the home sewer needs to be aware of the special problems involved in handling these fabrics. The correctness of the fabric grain is emphasized through all the handling processes of these fabrics. Careful consideration should be given to needle size and stitch length in relation to the weight of the fabric. This leaflet also suggests loosened tension and a slight pull on the fabric when stitching. For neat, durable stitching both mercerized cotton and synthetic threads are suggested. Taslan textured nylon thread made specially for man-made fabrics represents the latest development in synthetic thread and is especially recommended for these wash and wear fabrics.

Elore (3), defines textured yarns as; "continuous-filament yarns that have been modified so that the filaments do not lie parallel to each other." According to a Chemstrand Technical Information bulletin (4), "The process for producing Taslan textured yarn consists of feeding a yarn through the turbulent region of an air jet at a faster rate than it is drawn off by take-up rolls on the far side of the jet. ... In the jet, the yarn structure is opened, loops are formed, and the structure is closed again." The characteristics of yarns produced by the Taslan process as listed in America's Textile Reporter for July 12, 1962 (18) are: (1) higher denier, (2) much greater covering power, (3) strong, (4) will not stretch, (5) greater bulk, (6) drier hand, and (7) subdued luster. A DuPont Technical Information bulletin (6), suggests that "textured threads made by the Taslan process are especially well suited for home sewing because seams in the finished garment will be neater and more durable than seams sewn with other threads." This thread is available in a variety of colors and is recommended to take the place of silk threads in sewing on wool.

According to Lewis (10), mercerized cotton thread, size fifty, may be used for any fabric except a very glossy one. Mercerization is a process where fibers, yarns, or fabrics are treated with a caustic alkali solution, to add luster and smoothness to the texture of the yarn and also increase the strength and absorbency. Continuing from Lewis (10), "Silk thread is stronger than cotton but is suitable only for garments that are to be drycleaned. ... Nylon and Dacron polyester threads are strong but should be used only on synthetics since they may melt at regular pressing temperatures." Also, synthetic threads are so elastic that seams sewn with them are likely to pucker and, in hand sewing, they are apt to twist and knot. No mention is made by Lewis of Taslan nylon thread, however, and DuPont (6), reports that because of the special texturing process Taslan nylon threads do not stretch, and knot as other synthetic threads have done.

Man has been using natural fibers as textiles for centuries but has been synthesizing his own textile fibers for a relatively short time. One recent development has been to combine natural fibers with some of the man-made fibers in an effort to give the new fabric the advantages of both. Textile World's Fiber-blend Chart-1961 (13) says, "The blending of different fibers is not a new concept. ... Combinations of wool and cotton have been used in Europe for many years." Today, the commercial development of man-made fibers has opened up a vast new area of fiber combinations. The rapid increase in non-cellulosic man-made fibers has made possible new combinations of fibers for aesthetic and utilitarian purposes.

Fibers can be combined in many forms such as, filament warp and spun filling; fibers in yarn form, alternating throughout a warp; pile yarns of one fiber and ground yarns of another. The most common is the intimate-fiber blend where the fibers are blended during the manufacture of the yarn. In this process the fibers are first drawn out into long continuous strands called filaments and then large groups of continuous filaments are combined with out twist into tow. Tow can be cut into any desired length, after such cutting it is called staple. The short sections of fiber, or staple, may be crimped, twisted or spun, just as cotton and wool are spun. Staple of various lengths is provided to match the staple length of natural fibers with which it is to be mixed. Thus man-made fiber blends which resemble cotton, silk, linen, and wool may be produced. When fibers are blended as staple the process continues much as it does for the natural fiber alone (11).

Fiber blends, particularly with non-cellulosic fibers, have been developed for sound reasons. Many new fibers when first introduced were hailed as "miracle" fibers that could stand alone, unblended with natural fibers. In many instances this proved true— rayon and nylon tire cord, nylon hosiery, and industrial materials, to mention a few. But for the spun-yarn apparel fabrics the blending of man-made and natural fibers offers greater fabric improvements, with fewer objectionable qualities than an unblended man-made fiber would offer.

Requirements for the apparel fabrics involve several subjective qualities - hand, drape, luster, and comfort. With the proper percentage combinations of man-made and natural, or other man-made fibers, the desirable features of both fibers tend to predominate and to overshadow some of the less desirable features of each fiber. A wool-like, wool-nylon blend, for instance, offers higher-strength, lighter-weight, greater dimensional stability and less wrinkling than an all wool fabric. Blends thus provide fabric and garment designers with a new tool for achieving top performance, maximum aesthetic value and good style.

Most of the present research that has been done on construction techniques for man-made fibers has been done by various commercial concerns. It is their hope that the suggestions they offer will make sewing on man-made fibers more satisfying for the home sewer. Regarding these problems of construction techniques on fabrics made of man-made fibers, Shelden (14), poses the questions: "Should some of the old ones be discarded or reworked? .. What should be retained? ... What new ones can be devised?" To help answer these questions a graduate workshop was planned at Oregon State College. The workshop was planned for five laboratory groups of six each, with six preselected fabrics per group, one for each student. The fabrics represented popular fabrics for spring and summer; three cottons - one textured, one drip dry and the third a satin; and three blends - a Dacron polyester and cotton, a silk and cotton, and an Arnel triacetate and cotton. Each group prepared hems and seams using basic construction techniques commonly used and agreed upon ahead of time. Because some research workers have shown that it is cleansing rather than wear that causes seam and seam finish deterioration it was considered desirable to subject the samples to selected cleaning methods. After washing samples ten times each group, working with like fabrics, compared their results, made generalizations, and drew up conclusions and recommendations. In group discussion, very free criticism was given, both pro and con, concerning the method of testing and the results. Because of the many people involved it was felt that the variables were perhaps too great for accurate results. Many possible subjects, both interesting and of value for master's study were found by this work-shop. Problems of this type are especially meaningful to people who are teaching construction. One point all agreed on was the fact that our techniques all need to be re-evaluated in the light of our use of modern fibers in fabrics and sewing threads.

CHAPTER III

METHOD OF PROCEDURE

Selection of Fabrics and Threads

In an effort to simulate the conditions of the home sewer, fabrics for this study were purchased on the open market. The three fabrics chosen were of plain weave and had similar thread counts in both warp and filling. These wool and wool-like flannel fabrics are shown in Plate I. In order to obtain fabrics from two areas the fabrics were purchased from two bolts, making it necessary in the case of the wool-nylon blend and the rayon-acetate blend to use different colors of fabric. A 100 per cent virgin wool coded as W, W-I for area one and W-II for area two; a blend of 85 per cent wool and 15 per cent nylon coded as WN, WN-I and WN-II for areas one and two respectively; and a blend of 50 per cent rayon and 50 per cent acetate to be referred to as RA, RA-I, and RA-II, were selected because of their similar structure and varying fiber content. Hereafter fabrics will be referred to by their code letters.

In order to increase the possibility of thread being from different areas and thus decrease the possibility of flaw, six spools were purchased in six different colors, three purchased in each of two different locations. Threads chosen for the study were mercerized cotton size 50, and Taslan nylon thread.

Preparation of Samples

Three samples were cut from each of the two areas of fabric in an effort to lessen the possibility of flaw in the fabric construction. Fabrics were cut four by four inches in accordance with the standards set

EXPLANATION OF PLATE 1.

Fabrics used in seam construction

Figure 1. W
100 per cent wool fabric

Figure 2. WN
85 per cent wool
15 per cent nylon fabric

Figure 3. RA
50 per cent rayon
50 per cent acetate fabric

PLATE 1

Area W-I

Area W-II

Figure 1

Area WN-I

Area WN-II

Figure 2

Area RA-I

Area RA-II

Figure 3

by the American Society for Testing Materials, Committee D-13 (1), designation D 1683 - 59T, for testing seams which have been cut before sewing. Plain seams and flat felled seams were constructed in the warp-wise, filling-wise and off-grain directions. Care was taken to construct the seam keeping the direction of the yarn in the fabric perpendicular to the seam except for the off-grain seams.

The angle of the seam for samples sewn in an off-grain direction was determined by calculating the angle formed by seams from the waist to seven inches below the waist line. Commercial Standard C5215-58 of the United States Department of Commerce (19), was used for measurements ranging from misses size 23-1/2 to misses 34-1/2. The difference between waist measurement and seven inches below the waist was calculated and the size of each angle figured. A mean of seventy degrees was determined and used for all specimens cut at an angle. A light weight cardboard pattern was used in the cutting of each specimen.

A standard 501 Singer sewing machine with a size fourteen needle was used for all stitching. This size needle is suggested in a number of publications for use on medium weight woolens. The throat-plate with a small round hole that corresponds to the needle was used. A wide oval opening used for zig-zagging was found to cause some seam pucker. Nine and fifteen stitches per inch were counted and the stitch regulator marked to insure the same number of stitches on each set of samples. Tension was set as nearly as possible to balance and was not changed throughout the stitching.

All seams were stitched with five-eighths of an inch seam allowance. Plain seams were not finished in any way. Flat felled seams were stitched at five-eighths inch and one seam allowance was trimmed to one-fourth inch before the other seam allowance was turned under and edge stitched. One set of samples was stitched with mercerized cotton thread at fifteen stitches per inch. A second set at nine stitches per inch again using the mercerized cotton thread. Like sets were stitched with Taslan nylon thread at fifteen and nine stitches per inch. All samples numbered one were stitched with spool number one; samples two with spool number two and so on through the six of cotton and the six of nylon threads.

Specimens were pressed with a General Electric Steam iron on a dry, wool setting. A damp pressing cloth was used for all pressing, the cloth was dampened only once for each sample. All samples were pressed four times in the warp direction on the wrong side and four times in the filling direction on the right side.

Analyses of Fabrics and Threads

Fabrics were analyzed for number of threads per inch both warp and filling, weight per square yard, thickness and warp and filling breaking strengths. All specimens were brought to standard conditions before testing was done. After seams had been constructed a light weight cardboard template was used to mark the position of the jaws of the machine to insure the placement of the seam in the center between the jaws of the testing instrument. Breaking strengths were determined using the grab method and a pendulum type fabric tester according to the A.S.T.M., designation D 1683 - 59T.

Thread strengths were determined on a pendulum type instrument modified according to A.S.T.M. designation D 204 - 57T. Ten threads picked at random from the six spools of cotton thread were laid parallel on sticky tape placed five inches apart. Each of the six spools were represented in each sample. The jaws of the testing instrument were five inches apart at the start of the test. The same method was used for the Taslan nylon thread. Ten specimens from each type of thread were tested and a mean was calculated for the strength of a single strand of each type of thread.

The data were analyzed with the assistance of the statistics laboratory according to Snedecor (15). For this purpose areas one and two of all fabrics were treated as one sample. Six seams, three from each area, representing each variable were tested, if a specimen slipped in the jaws of the machine or broke too near the jaw it was discarded. In groups where all specimens were valid one was picked at random to be thrown out.

CHAPTER IV

DISCUSSION OF RESULTS

It is assumed that the strength of seams is influenced by many factors, some of which are; type of thread, type of seam, number of stitches per inch, and direction of the warp and filling yarns in relation to the seam. This study was designed to compare two kinds of seams, plain and flat felled, and the variables which influence their strength. Three wool and wool-like fabrics, two thread types, two stitch lengths, and three directions of the fabric were the variables applied to the two types of seams chosen.

Physical Properties of Fabrics and Threads

Yarn count, weight per square yard, thickness and warp and filling breaking strengths were the physical characteristics studied.

Yarn Count. The yarn counts of the three fabrics were very similar. Fabric W had a slightly higher count in both warp and filling and WN the lowest of the three fabrics. The largest difference was in the filling of fabric W, with twenty-nine yarns and the filling of the other two fabrics, with twenty-five yarns per square inch. There was no difference in yarn count for lots one and two. Yarn counts for all fabrics and the two areas are shown in Table I.

Weight Per Square Yard. Fabric W had the greatest weight, 6.4 ounces per square yard. Fabric RA was the lightest weighing only 5.3 ounces per square yard, making a total difference of 1.1 ounces per square yard. Because of the slight difference in weight of WN-I and WN-II the weights for both areas are shown in Table I, along with the mean for each fabric.

Table I. Physical properties of selected wool and wool-like fabrics

Fabric	Weight per Square yard	Thickness at 1 lb/sq. in.	Thread Count		Breaking Strength	
			Warp	Filling	Warp	Filling
	Ounces	Inches	Number per inch	Number per inch	Pounds	Pounds
W	6.4	.0034	34	29	31.6	24.8
W-I	6.4	.0034	34	29	32.0	25.7
W-II	6.4	.0034	34	29	31.2	23.9
WN	6.0	.0032	31	25	42.3	30.3
WN-I	5.8	.0032	31	25	46.2	31.7
WN-II	6.2	.0032	31	25	38.5	29.0
RA	5.3	.0032	32	25	61.1	42.6
RA-I	5.3	.0033	32	25	63.3	41.6
RA-II	5.3	.0031	32	25	59.0	43.6

It is interesting to note the weight difference for man-made and natural fibers. The increase in percentage of man-made fiber brought a decrease in the weight of the fabric.

Thickness. Thickness of the three fabrics differed only slightly, fabric W being the thickest at .0034 inch. Fabrics WN and RA averaged the same mean thickness of .0032 inch, however there was some difference in the thickness of RA-I and RA-II as shown in Table I.

Breaking Strength of Fabrics. The mean warp and filling breaking strengths of fabric RA were the greatest, with a difference of nearly thirty pounds between the mean warp breaking strength of RA and the mean warp breaking strength of fabric W. A difference of 17.8 pounds was shown in the filling direction of fabrics W and RA. Areas one and two of fabrics WN and RA showed some difference in breaking strength in both warp and filling as is shown by Table I. These two fabrics were purchased from two separate bolts and in two different colors. Specimens are shown in Plate 1, page 16. It should be noted that for this group of fabrics the higher content of man-made fibers also resulted in the higher breaking strength of fabrics.

Breaking Strength of Thread. Results of the breaking strengths of the ten specimens broken showed the Taslan nylon thread to be only slightly the stronger of the two types of thread. Mean breaking strength for Taslan nylon thread was 2.02 pounds per thread and for mercerized cotton 1.99 pounds per thread, in five inches. The amount of elasticity in the Taslan nylon thread was, however, greater than that shown by the cotton thread.

In many instances it was shown that seams were more durable than fabric thus the fabric ruptured at a lower breaking point than the seam would have. In the hope of presenting a truer picture of the relationship between seam strengths and fabric strengths, visual observations were made during the testing. Three different observations of each breaking test were noted: (1) fabric rupture, where the fabric proved weakest and broke first, (2) thread rupture, where the type of thread and/or stitch length resulted in the seam itself breaking first, (3) yarn slippage, the yarns of the fabric raveled where the seam was stitched.

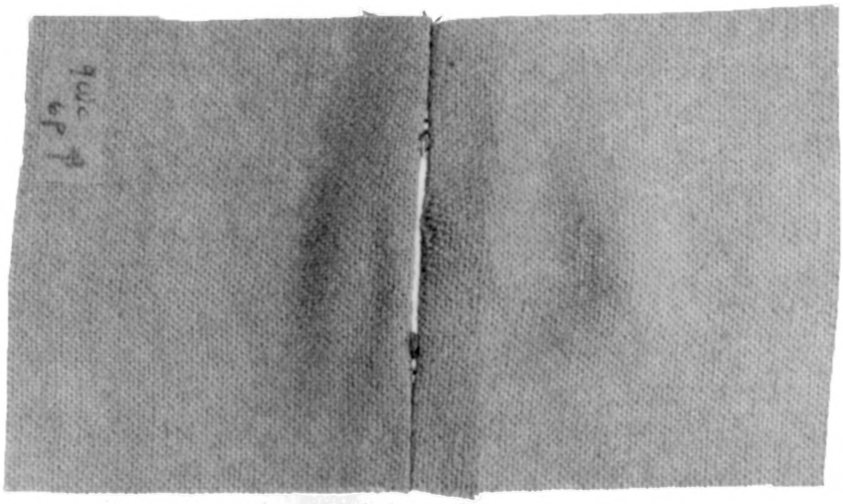
Breaking Strength of Seams

Plain Seams. The breaking strength of plain seams in fabric RA showed a greater mean breaking strength in those seams stitched with fifteen stitches per inch than those with nine. In the cases of fabrics W and WN the fabric ruptured before the seam broke thus rendering the test invalid as far as these fabrics were concerned. There was some yarn slippage along the seams in fabric WN and RA. No difference in yarn slippage was noted when nine and fifteen stitches per inch were used. Very little yarn slippage was noted for fabric W which had the lowest breaking strength of the three fabrics. The destruction of plain seams on the three fabrics is illustrated in Plate 2. It can be seen that in fabric W the seam is not even pulled, in fabric WN the seam broke but at the same time there was also some yarn slippage at the seamline, while in fabric RA the thread ruptured causing the seam to break but leaving the fabric intact. If the plain seams broke in fabric WN it was when the plain seams were stitched with cotton thread at nine stitches per inch and in warp-wise and off-grain directions. This was also evident in fabric RA where plain seams stitched with cotton thread and nine stitches per inch had the lowest mean breaking strengths of any seam constructed from that fabric, see Table II. Plain seams stitched with

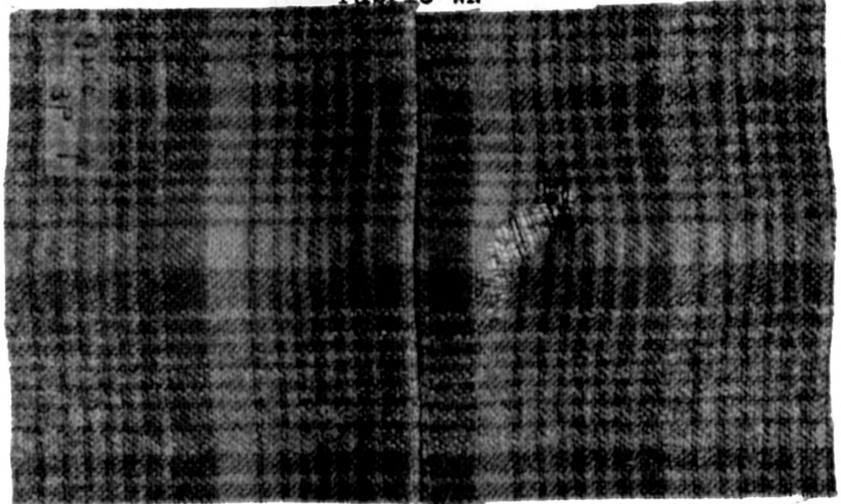
EXPLANATION OF PLATE 2

The destruction of the plain seam showing how the fabrics differed in the degree of destruction. The seams were all stitched with cotton thread at nine stitches per inch in the warp direction.

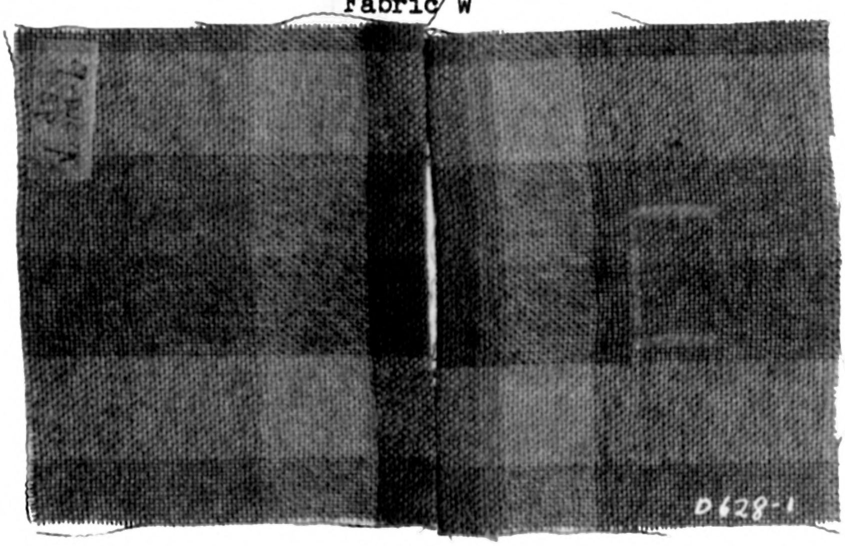
PLATE 2



Fabric WN



Fabric W



Fabric RA

Table II. Mean breaking strength, in pounds, of fabrics constructed with plain and flat felled seams and stitched with two kinds of thread

Direction of Seam and Stitches/inch	Plain Seam		Flat Felled Seam	
	Taslan Nylon Thread	Cotton Thread	Taslan Nylon Thread	Cotton Thread
		WOOL		
Warp				
9 Stitches/inch	34.5	33.0	33.7	32.3
15 Stitches/inch	32.1	31.8	33.3	31.9
Filling				
9 Stitches/inch	28.2	25.4	25.8	25.3
15 Stitches/inch	25.3	24.0	25.3	24.4
Off-grain				
9 Stitches/inch	30.9	21.9	28.9	28.4
15 Stitches/inch	29.7	30.5	29.7	32.2
		WOOL-NYLON		
Warp				
9 Stitches/inch	47.4	38.7	43.3	42.0
15 Stitches/inch	42.2	43.4	43.9	42.1
Filling				
9 Stitches/inch	32.0	32.7	30.8	32.8
15 Stitches/inch	33.0	31.7	30.2	29.8
Off-grain				
9 Stitches/inch	37.7	37.6	34.6	35.5
15 Stitches/inch	35.1	35.9	34.9	35.1
		RAYON-ACETATE		
Warp				
9 Stitches/inch	43.8	32.0	46.6	50.6
15 Stitches/inch	45.2	52.0	63.6	60.8
Filling				
9 Stitches/inch	41.6	29.0	43.0	42.4
15 Stitches/inch	38.2	38.4	48.0	42.2
Off-grain				
9 Stitches/inch	41.6	35.0	47.0	45.2
15 Stitches/inch	40.6	41.2	47.4	46.8

Taslan nylon thread had a slightly higher mean breaking strength than those stitched with cotton at both nine and fifteen stitches per inch.

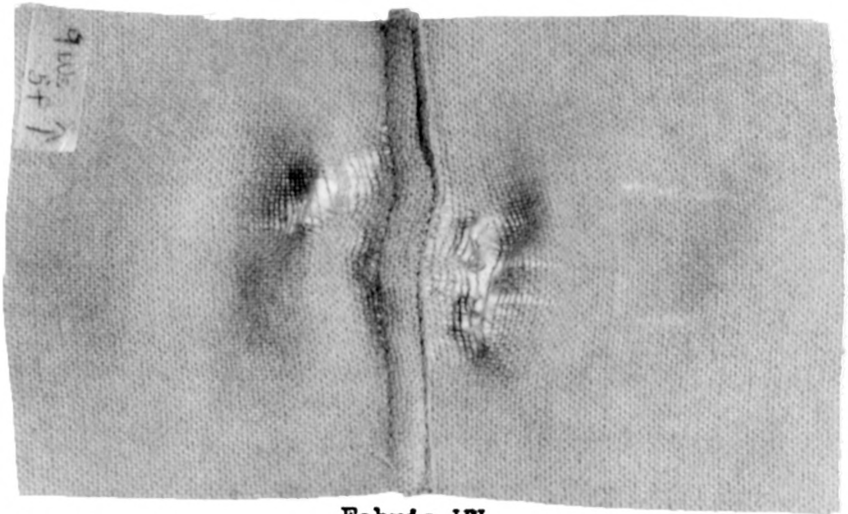
It would appear that for fabrics W and WN either of the two types of seam would be adequate. While for fabric W either thread type or stitch length was adequate, seams in fabric WN appeared to be stronger when stitched with fifteen stitches per inch. For fabric RA the plain seam was strong enough only when stitched with fifteen stitches per inch. Very little difference was noted in the type of thread used.

Flat Felled Seams. In fabric RA, flat felled seams proved to be much the stronger of the two types. This can be seen in the higher mean breaking strengths of these seams as shown in Table II. In fabrics W and WN the fabrics broke leaving the seam nearly intact in most cases. The breaking strength of flat felled seams in fabric RA was considerably greater than for plain seams. Flat felled seams stitched with fifteen stitches per inch had a higher mean breaking strength than those stitched with nine stitches per inch. The higher mean breaking strength was also shown for those seams where Taslan nylon thread was used. The greatest mean breaking strength of seams in fabric RA was shown where they were stitched with Taslan nylon thread at fifteen stitches per inch. A high degree of yarn slippage was shown in seams stitched with nine stitches per inch using the Taslan thread. Plate 3 illustrates the appearance of flat felled seams in all three fabrics after breaking. Fabric RA broke at the seam, and also away from the seam, some yarn slippage and a pulling of the seam were also apparent. In fabric WN the seam did not break, but neither was it an acceptable seam since it was pulled out of shape, and there was noticeable yarn slippage. The seam in fabric W was unharmed and the fabric broke at the point where the seam

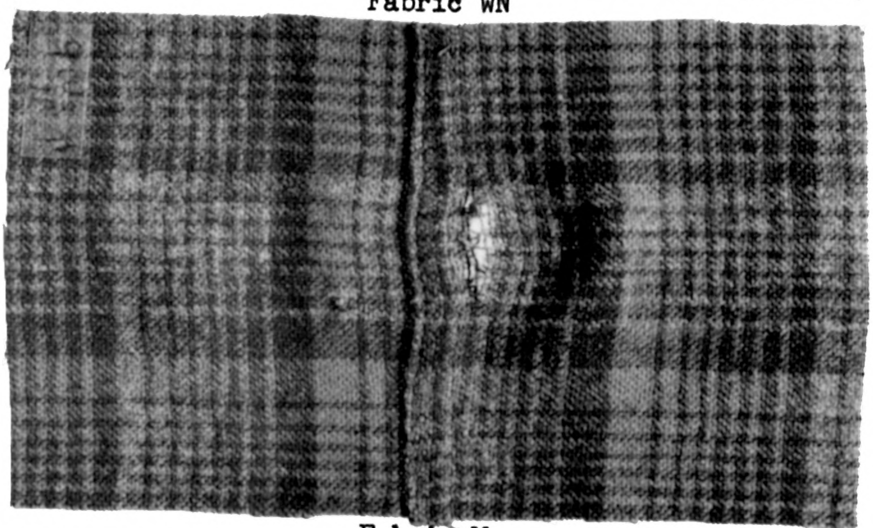
EXPLANATION OF PLATE 3

The destruction of the flat felled seams showing how the fabrics differed in the degree of destruction. The seams were stitched with Taslan nylon thread at nine stitches per inch in the warp direction.

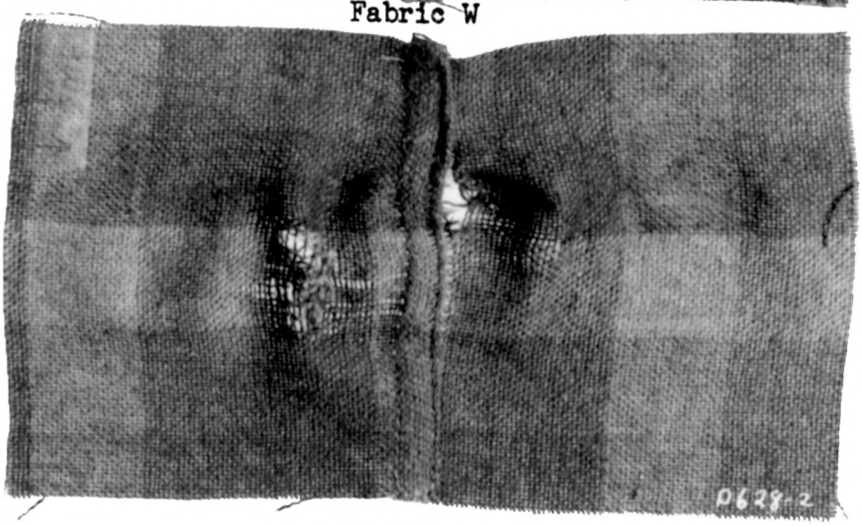
PLATE 3



Fabric WN



Fabric W



Fabric RA

was stitched. Examples of the breaking of the flat-fell seam in off-grain specimens are shown in Plate 4. It will be noted that in no case was the seam ruptured but the degree of yarn slippage varies with the three fabrics. It is also interesting to note the direction of the fabric rupture in relation to the direction in which the seam was stitched.

Analyses of Data

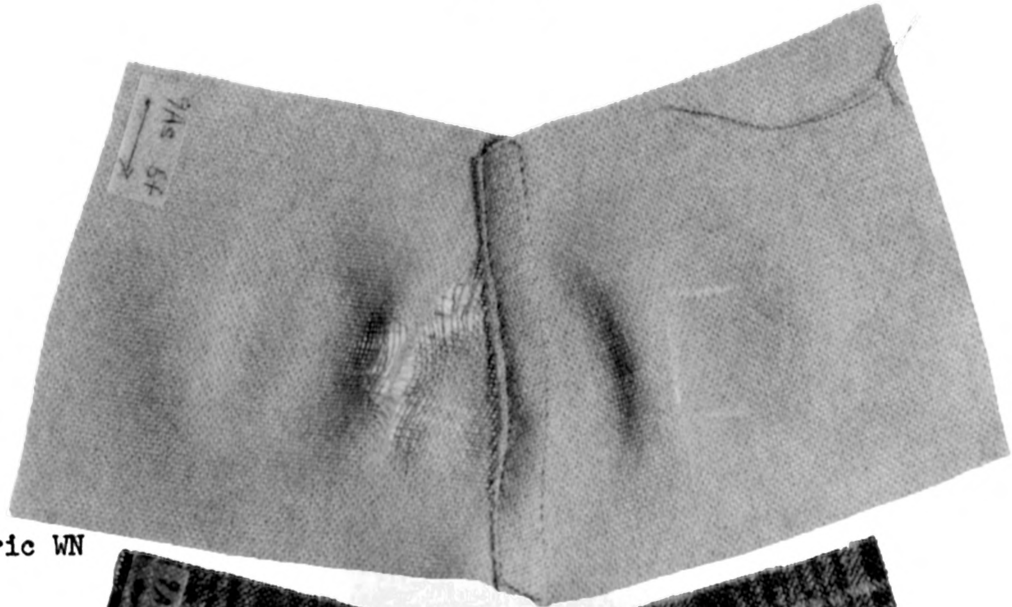
Due to the low breaking strength of fabrics W and WN both the plain and flat felled seams proved to be stronger than the fabrics themselves in the majority of cases. The analysis of variance does not show this since breaking strengths were recorded whether fabric or seam rupture occurred. It should be kept in mind that for fabrics W and WN most figures indicate breaking strength of fabric, and the seams were left nearly intact. This was true with all of the specimens of fabric W and with the majority of those for fabric WN, however many of the seams in fabric WN were pulled and yarn slippage was observed frequently. The mean breaking strengths of fabrics and seams are found in Table II, page 26. It will be noted that nearly all seams made with fabric RA have a higher, mean breaking strength than those of the other two fabrics. Analyses of variance, for the breaking strength of warp-wise seams, are shown in Table IV, of filling-wise seams in Table V, and of off-grain seams Table VI, (Appendix A).

The analyses of variance shown in the above mentioned tables show how the variables relate to one another. The interaction of fabrics, threads, seams and stitch length was significant at the .05 level in the filling but showed no significance in either warp-wise or off-grain seams. A relationship significant at the .01 level for thread, seam and length

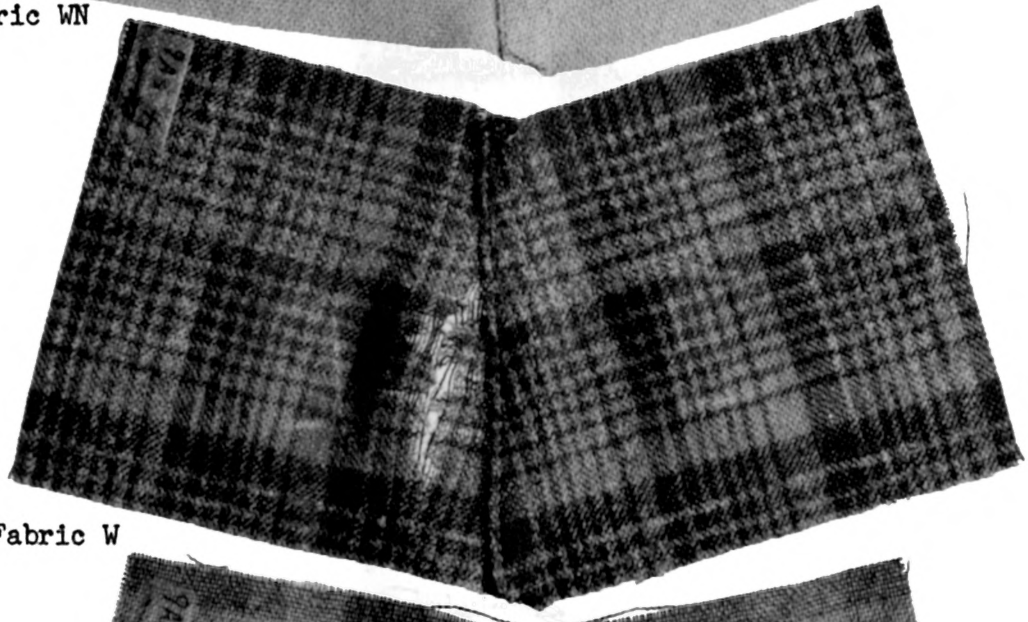
EXPLANATION OF PLATE 4

The destruction of fabrics with seams stitched at a seventy degree angle. The flat felled seams were stitched with Taslan nylon thread at nine stitches per inch.

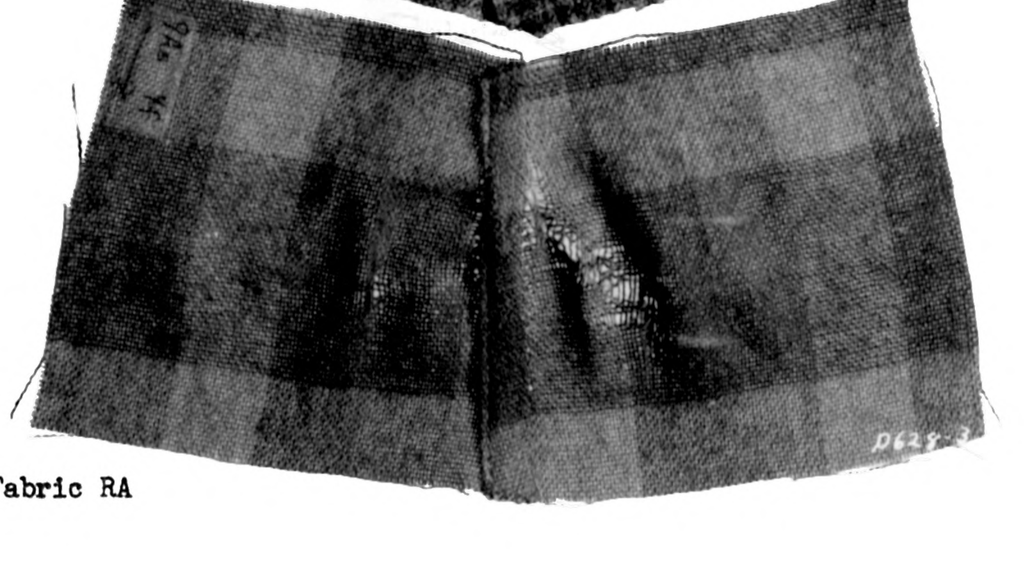
PLATE 4



Fabric WN



Fabric W



Fabric RA

of stitch, was shown for the filling-wise seams but not for warp and off-grain seams. Seams stitched so that the pull of the jaws of the testing instrument was in a filling-wise direction had the lowest mean breaking strengths throughout the testing.

Fabric, thread, and stitch length showed a significant relationship in the warp at the .01 level but none was shown for filling or off-grain seams. Warp seams were stitched so that the pull of the jaws of the testing instrument was in the warp-wise direction and these seams and fabrics showed the greatest average mean breaking strengths throughout the testing. Off-grain seams were those stitched at a seventy degree angle, therefore the pulling of the testing instrument was on both warp and filling yarns. The off-grain seams showed an average mean breaking strength greater than the filling-wise seams but less than the warp-wise seams. The thread and stitch length, as interaction variables, showed a significance of .001 in the warp and .05 for off-grain seams, no significance was shown in the filling seams. The fabric in relation to stitch length was significant at the .001 level in warp-wise seams, at the .05 level in filling-wise seams and was not significant in off-grain seams.

The total mean breaking strengths of all warp, filling and off-grain, plain and flat felled seams are given in Table III. Fabric RA shows significance at the .001 level for all seam directions in relation to stitch length and type of seam, the flat felled seam being the stronger of the two types. Fabrics W and WN showed no significant differences. In fabrics W and WN most of the seams, regardless of direction, were strong enough to withstand the strain of the testing instrument. Fabric RA showed the greatest mean breaking strength in the warp-wise seams, and fabric W the lowest total mean breaking strength in the filling-wise seams.

Table III. Significance of total mean breaking strength in pounds of three fabrics and three directions

Fabric	Warp		Filling		Off-grain	
	Plain Seam	Flat Felled Seam	Plain Seam	Flat Felled Seam	Plain Seam	Flat Felled Seam
W	32.875	33.112	25.862	25.450	30.175	29.462
WN	43.300	42.575	33.238	30.925	36.775	35.538
RA	42.250	59.850***	36.750	43.475***	39.525	46.638***

*** significant at .001 level

CHAPTER V

SUMMARY AND RECOMMENDATIONS

The purpose of this study was to: (1) ascertain the relative strength of the plain seam and the flat felled seam in a 100 per cent wool fabric (W), an 85 per cent wool - 15 per cent nylon blend fabric (WN), and a 50 per cent rayon - 50 per cent acetate blend fabric (RA); (2) to compare the effectiveness of nine stitches per inch and fifteen stitches per inch as used in the plain seam and in the flat felled seam on the three fabrics; (3) to compare the effectiveness of mercerized cotton thread and Taslan nylon thread as used in the two seams and on the three fabrics; and (4) to compare the strength of the two seams in relation to the lengthwise, crosswise and off-grain directions of the three fabrics.

The physical properties of the fabrics were similar except for the breaking strength which was thirty pounds higher in the warp of fabric RA than it was in the warp of fabric W. Other properties studied were yarn count, weight per square yard, thickness and breaking strength.

All seams stitched in fabrics W and WN proved to be stronger than the fabrics themselves. It would seem safe therefore to conclude that for these two fabrics either seam would work equally well, and the choice would depend upon the location, appearance and the desire of the individual. Plain seams were not strong enough for fabric RA as was shown by the high degree of significance of strengths of flat felled seams over plain seams. It would seem wise therefore for the home sewer to use this type of seam wherever possible in the construction of garments made of rayon-acetate wool-like fabrics. If for reasons of appearance or location this were not possible then a substantial plain seam could be constructed by using a Taslan nylon thread and stitching at fifteen stitches per inch.

Research conducted by Coon (5), also showed the flat felled seam to be stronger than the plain seam. This study found that in general fifteen stitches per inch showed greater strength than nine. In further agreement, the study done by The United States Bureau of Human Nutrition and Home Economics in cooperation with the Ohio State University and the Ohio Agricultural Experiment Station (22), found that flat felled seams were the strongest of those they studied.

It would seem of value to conduct additional tests similar to this one. Because of the weakness of fabrics W and WN it might be better to choose fabrics made entirely of blends of man-made fibers. A greater variety of types of seams could perhaps be constructed. This would be helpful to home sewers in determining the quality of the different seams, and in choosing the best one for individual needs. This type of study could also be done using seams that were constructed before they were cut, as those in ready made garments. Study and testing could also be done to determine the effect of cleaning methods on the appearance and wear of seams in wool-like flannel fabrics. In order to learn more about construction techniques subjective evaluations of seams and stitches would also be of real value.

Further research also needs to be done on types of thread and the length of the stitches. Taslan nylon thread is new on the market and very little has been done to determine its value to the home sewer. The recent recommendation for shortening the stitch length needs to be investigated in an effort to ascertain its value, its advantages and disadvantages, to the home sewer.

ACKNOWLEDGMENT

Sincere appreciation is expressed to Miss Esther Cormany, Associate Professor of Clothing and Textiles, for her assistance and guidance in directing this study. Appreciation is also expressed to Dr. Stanley Wearden and Dr. Leslie F. Marcus for their help with the statistical analysis.

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APPENDIX A

Table IV. Analysis of variance for breaking strength of warp-wise seams

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F	Significance
Fabrics	2	2617.1679	1308.5840	15.38	*
Threads	1	102.9602	102.9602	13.62	**
Seams	1	390.4502	390.4502	51.66	***
Lengths	1	61.8802	61.8802	8.19	**
F × T	2	31.0829	15.5414	2.06	ns
F × S	2	850.9179	425.4590	56.30	***
F × L	2	153.4805	76.7402	10.15	***
T × S	1	4.2602	4.2602	.56	ns
T × L	1	170.6302	170.6302	22.58	***
S × L	1	5.5352	5.5352	.73	ns
F × T × S	2	18.9680	9.4840	1.25	ns
F × T × L	2	93.0704	46.5352	6.16	**
F × S × L	2	23.9904	11.0052	1.59	ns
T × S × L	1	20.1503	20.1503	2.67	ns
F × T × S × L	2	4.0453	2.0226	.27	ns
Error (b)	21	158.7069	7.5575		
Total	47	4962.6148			

N = 48

* significant at .05 level

** significant at .01 level

*** significant at .001 level

ns nonsignificant

Table V. Analysis of variance for breaking strength of filling-wise seams

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F	Significance
Fabrics	2	1678.7455	839.3728	55.60	**
Threads	1	59.4075	59.4075	10.87	**
Seams	1	21.3334	21.3334	3.90	ns
Lengths	1	.0300	.0300	.00(5)	ns
F × T	2	35.8962	17.9481	3.28	ns
F × S	2	181.6403	90.8202	16.61	***
F × L	2	51.4587	25.7294	4.71	*
T × S	1	18.0075	18.0075	3.29	ns
T × L	1	4.4409	4.4409	.81	ns
S × L	1	.3333	.3333	.06	ns
F × T × S	2	1.1513	.5756	.11	ns
F × T × L	2	12.1129	6.0564	1.11	ns
F × S × L	2	.8705	.4352	.08	ns
T × S × L	1	49.2074	49.2074	9.00	**
F × T × S × L	2	43.8013	21.9006	4.01	*
Error (b)	21	114.8013	5.4667		
Total	47	2318.5267			

N = 48

* significant at .05 level

** significant at .01 level

*** significant at .001 level

ns nonsignificant

Table VI. Analysis of variance for breaking strength of off-grain seams

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F	Significance
Fabrics	2	1408.0717	704.0358	12.92	*
Threads	1	2.6602	2.6602	1.16	ns
Seams	1	35.5352	35.5352	15.47	***
Lengths	1	6.2352	6.2352	2.72	ns
F × T	2	10.9017	5.4508	2.37	ns
F × S	2	174.9717	87.4858	38.10	***
F × L	2	7.2217	3.6108	1.57	ns
T × S	1	1.1719	1.1719	.51	ns
T × L	1	16.2169	16.2169	7.06	*
S × L	1	.3502	.3502	.15	ns
F × T × S	2	3.7849	1.8924	.82	ns
F × T × L	2	8.8849	4.4424	1.93	ns
F × S × L	2	6.8716	3.4358	1.50	ns
T × S × L	1	5.6719	5.6719	2.47	ns
F × T × S × L	2	3.2551	1.6276	.71	ns
Error (b)	21	48.2231	2.2963		
Total	47	1903.4598			

N = 48

* significant at .05 level

** significant at .01 level

*** significant at .001 level

ns nonsignificant

APPENDIX B

McCALL CORPORATION
230 PARK AVENUE, NEW YORK 17 . . NEW YORK

July 8, 1963

Miss Connie Kyle
Department of Clothing & Textiles
Justin Hall
Kansas State University
Manhattan, Kansas

Dear Miss Kyle:

The figures I gave at the meeting in Kansas City were taken from a Seventeen Ad. I believe I took it from WOMEN'S WEAR DAILY. I am sure if you wrote Seventeen Magazine they could send you more information from this survey.

Although home sewing is increasing it is not increasing at the same rate as the population growth. You may quote me if you wish.

I am enclosing a copy of a survey we did a few years ago which may have some helpful information for you.

Cordially,

Mildred G. Ryan

Mildred G. Ryan
Educational Director
McCall's Patterns

MGR/ro
enc.

EFFECT OF STITCH LENGTH AND TYPE OF THREAD ON THE STRENGTH OF SEAMS IN WOOL AND WOOL-LIKE FABRICS

by

CONNIE ROGENE KYLE

A. A. Graceland College, 1952
B. S. Montana State College, 1956

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Clothing and Textiles

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1964

This study was undertaken to ascertain the relative strength of the plain and flat felled seam when subjected to controlled variables of stitch length, type of thread, and warp-wise, filling-wise, and off-grain directions of the fabric. Blends of wool and man-made fibers were selected to compare with wool because blending of man-made and natural fibers is a fairly recent development of the textile industry. Three wool-like flannel fabrics, one 100 per cent wool; one 85 per cent wool - 15 per cent nylon; and the third a 50 per cent rayon - 50 per cent acetate blend, were chosen. Fabrics were purchased on the open market and in two areas each. Mercerized cotton thread size 50 and a textured Taslan nylon thread were also purchased on the open market, and in six different colors to insure their being from different lots.

Sets of six plain and six flat felled seams were constructed from each fabric using mercerized cotton thread at nine stitches per inch. A second set of each seam type was constructed at fifteen stitches per inch again using the cotton thread. Other sets were constructed for both seam types and the three fabrics, this time using Taslan nylon thread, again at nine and fifteen stitches per inch. Like sets were constructed for warp-wise, filling-wise and off-grain directions of each fabric.

Fabrics, as purchased, were analyzed to determine weight per square, thickness, yarn count and breaking strength of both the warp and filling. The three fabrics were similar in yarn count, thickness and weight per square yard, with the lightest fabric being the one with the highest percentage of man-made fibers. Breaking strengths varied rather markedly, the all wool fabric having a thirty pound lower mean breaking strength than did the rayon-acetate blended fabric, in the warp-wise direction. Analysis of the strength of threads showed little variation in the two types.

Analysis of variance was used to determine the significance for mean breaking strengths of the two types of seams. The strength of the flat felled seams over the plain seams was significant at the .001 level in the rayon-acetate fabric. Because seams constructed in the wool and wool-nylon fabrics were stronger than the fabrics themselves there was very little destruction of seams. Visual observations made during the testing showed a high degree of yarn slippage on seams constructed of the wool-nylon fabric and rayon-acetate fabric, while very little was noted for the all wool fabric. Since the all wool fabric broke easily seams were left unharmed. The majority of the seams in the wool-nylon fabric were pulled out of line and not left in acceptable condition even though they did not rupture. Seams in the rayon-acetate fabric ruptured in most cases. The highest mean breaking strengths were recorded for flat felled seams stitched at fifteen stitches per inch with textured Taslan nylon thread in the rayon-acetate fabric.

Very little difference in the breaking strengths of seams was due to the thread used to stitch the seams, the Taslan nylon thread being only slightly stronger. The slight difference shown in the seams by the length of stitches indicated that fifteen stitches per inch were stronger.

Further study needs to be done using stronger fabrics and perhaps a greater variety of seams. Because researchers have found that cleaning rather than strain is often the cause of wear in seams, such a study could perhaps include some selected cleaning methods, and some subjective evaluations of seams and stitching.