A COMPARISON OF THE EFFECT OF LAUNDERING AND OF ACCELEROTOR ABRASION ON THE BREAKING STRENGTH OF MATCHED UNTREATED AND TREATED FABRICS

by

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INTRODUCTION

The need to develop reliable, consistent, and rapid laboratory analysis to predict in-service fabric performance cannot be overemphasized. Of special concern are tests that can rapidly provide comparison of key performance characteristics and have good correlation with in-service performance (Handy, 1968). This is considered important so prompt identification of problems and promising treatments can be evaluated (Markezich, 1968). There are many problems connected with developing tests to predict in-service wear performance. For example, there are varying opinions concerning fabric wear in actual use and factors that affect fabric wear.

There is general agreement that the serviceability of an article is as long as that article is able to perform a useful service (Booth, 1968 and Skinkle, 1940). According to Kaswell (1953), the term serviceability is a broad category that encompasses all criteria of performance on which a fabric may be accepted or rejected for use. This makes the prediction of serviceability a complex problem, and researchers vary in their opinions of what is a good measure of serviceability (Maji, 1970).

One of the most important reasons for textile articles becoming unserviceable is abrasive wear. Wear, as defined by Booth (1968), is the net result of a number of agencies that reduce an article's serviceability. These agencies include bending, stretching, tearing, abrasion, laundering and cleaning. Skinkle (1940) has stated that in most cases abrasion is the most important factor in wear, and that abrasion consists of friction between the cloth and some other material.

Researchers vary in their opinions as to what factor causes the most abrasive wear (Handy, 1968 and Maji, 1970), how wear and abrasion resistance should be evaluated (Markezich, 1968), what method of evaluation should be used (Markezich, 1968) and what is the best instrument for determining abrasive wear (Maji, 1970 and Markezich, 1968). All of these factors contribute to the complexity of the problem, but they should not detract from the need for solution.

The need for reliable, consistent, and rapid laboratory analysis to predict in-service fabric performance was re-emphasized with the rapid expansion of "permanent press" or "durable press" fabrics. According to Markezich (1968), this demand for durable press and the resulting production haste was so great that the available laboratory test methods were not fully utilized. Many products that were not adequately pre-tested were withdrawn from the market because of unsatisfactory in-service performance. The main in-service problems with the wash-and-wear and durable press garments has been the accompanying strength loss, reduced abrasion resistance and lowered elongation that cause reduced garment wear life (Peterson, 1969 and Rollins, 1970). These problems are caused by the resins used in the wash-and-wear and durable press treatments. The stronger cross-links between the cellulose molecular chains, which are created by the resins, tend to resist breaking and pull the molecule back into place after the fiber is bent, thus preventing wrinkle formation. This change in the mechanical properties of the cellulose, while preventing wrinkle formation, also causes strength loss and lowered abrasion resistance due to the loss of elasticity and increased fiber embrittlement (Hollen, 1968). Industry's first solution to these problems was the use of "reinforcing" synthetic fibers blended with cotton; polyester/cotton being the most popular blend (Getchell, 1971 and Hollen, 1968).

There is a definite need for reliable, consistent, and rapid laboratory analysis to predict in-service fabric performance so that some of these same problems can be avoided in the future. The objective of this study was to compare the effects of multiple laundering with those of laboratory wear on matched untreated and treated fabrics.

MATERIALS AND METHODS

The fabrics used were the same as those used in Kansas State University Agricultural Experiment Station Research Project 769. Three matched pairs of plain woven shirting fabrics were selected. In each pair the fabrics were identical in fiber content and general physical characteristics, but one was untreated and the other was treated with a special finish. The fabrics were:

1. 100% cotton
2. 100% cotton with wash-and-wear finish
3. 50/50% cotton/polyester
4. 50/50% cotton/polyester with durable press finish
5. 65/35% polyester/cotton
6. 65/35% polyester/cotton with durable press finish and soil release finish

These fabrics were purchased from Test Fabrics, Inc.

The laundering procedure basically followed A.A.T.C.C. Test Method 130-1969. An automatic washer with a permanent press cycle and an automatic tumble dryer were used for laundering.

Two different detergents were used: A.A.T.C.C. Standard Detergent 124 and low-sudsing Dash. In each detergent group a total of 40 launderings were run, with a unit from each fabric being removed for physical testing after 5, 10, 15, 20, 30 and 40 series of launderings.

Abrasion tests using the Accelerotor were conducted on the fabrics as purchased according to a modified version of A.A.T.C.C. Test Method 93-1970. For each level of abrasion three warp and three filling samples (4 1/2 inches by 6 1/2 inches) from each fabric were subjected to wear periods of 1/2, 1, 1 1/2, 2, 3 and 4 minutes. The Accelerotor was operated with a 4 1/4 inch rotor at speed of 3,000 rpm. A fine grit liner was used in a polyurethane foam cushion collar. The abraded samples were then cut into six warp and six filling specimens for breaking strength tests.

Breaking strength tests were conducted on the laundered fabrics after 0, 5, 10, 15, 20, 30 and 40 series of laundering. Breaking strength tests were conducted on the abraded fabrics after 0, 1/2, 1, 1 1/2, 2, 3 and 4 minutes of abrasion. The test method procedure followed for the breaking strength was A.S.T.M. Test Method D 1682, Ravel Strip Method, on the Scott Testers Constant Rate of Extension (CRE) machine.

Statistical treatment of data was by analysis of variance. Least significant differences (LSD's) with a 0.05 protection level were determined. Although two different detergents were used, the effect of detergent was not an experimental variable for this study. Detergent type was included in the analysis of variance, however, to have a more accurate error term, but it will not be discussed.

RESULTS AND DISCUSSION

Warp Breaking Strength

Laundering. Three-way analysis of variance using the F test for significance at the 95 percent level showed significant differences with the following variables: detergent, fabric type, interaction between detergent and number of launderings, and interaction between number of launderings and fabric type. Significant differences were not found among number of launderings or for the interaction of detergent x number of launderings x fabric type (Table 1, page 7).

Analysis of warp breaking strength by fabric type showed that in every matched pair of fabrics the untreated fabric had a higher breaking strength than the treated fabric, and there was significant difference between them (Table 6, page 29).

Analysis of all cotton warp breaking strength by the interaction between number of launderings and fabric type showed that the untreated fabric had higher breaking strength than the treated fabric; and the untreated cotton means were significantly different from the treated cotton means, regardless of number of launderings (Figure 1, page 8). The effect of laundering upon the untreated cotton was the gradual decrease of breaking strength with the increase of launderings. The breaking strength means after thirty or forty launderings were significantly different from and lower than the means of the fabric as purchased or after five launderings (Figure 1, page 8). The treated cotton was not affected by laundering as the untreated cotton was. The treated fabric's breaking strength means after thirty and forty

Table 1. Analysis of Variance of Warp Breaking Strengths of Laundered Fabrics

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F-Value
Detergent Type	1	57.717	57.717	13.768*
Number of Launderings	6	37.994	6.332	1.511
Fabric Type	5	191418.188	38283.637	9132.500*
Detergent Type x Number of Launderings	6	59.251	9.875	2.356*
Det. Type x Fabric Type	5	74.282	14.856	3.544*
Number of Launderings x Fabric Type	30	288.296	9.610	2.292*
Det. Type x No. of Launderings x Fabric Type	30	174.902	5.830	1.391
Error	336	1408.519	4.192	
Total	419	193519.188		

Table 2. Analysis of Variance of Warp Breaking Strengths of Abraded Fabrics

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F-Value
Amount of Abrasion Time	6	46151.219	7691.867	137.630*
Fabric Type	5	22220.359	4444.070	79.518*
Amount of Abrasion Time x Fabric Type	30	9806.844	326.895	5.849*
Error	168	9389.141	55.888	
Total	209	87567.563		

*Significant at 95% level.

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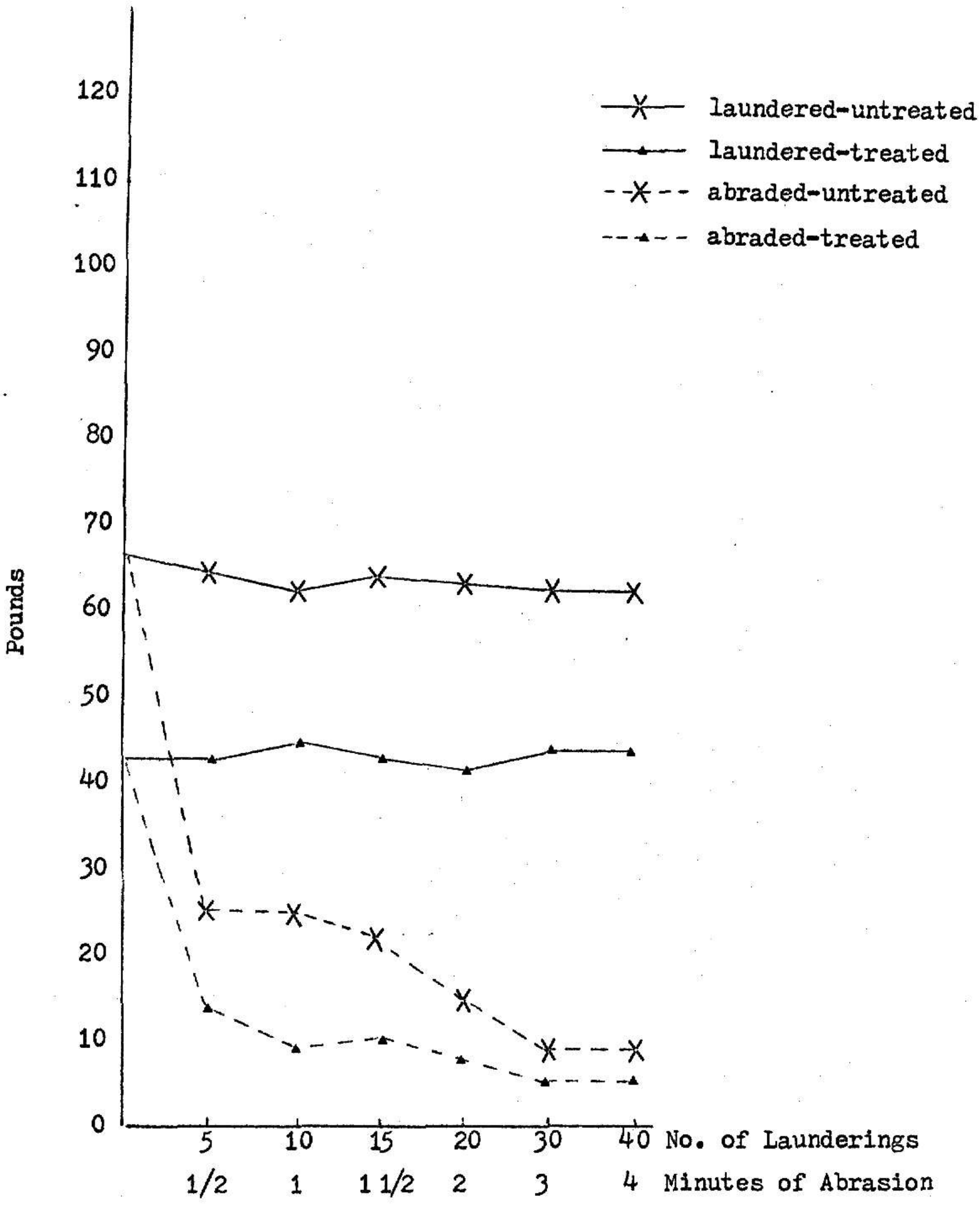

Figure 1. Warp Breaking Strength (in Pounds) of 100% Cotton Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

launderings were not significantly different from the means of the fabric as purchased or after five and ten launderings (Figure 1, page 8).

Analysis of the warp breaking strength of the 50/50 cotton/polyester blends by the interaction between number of launderings and fabric type showed that, regardless of number of launderings, the untreated fabric had higher breaking strength than the treated fabric, and the means of the untreated 50/50 blend were significantly different from the means of the treated 50/50 blend (Figure 2, page 10). The effect of laundering upon the untreated 50/50 blend was the gradual decrease of breaking strength with the increase of launderings. The breaking strength mean after forty launderings was significantly different from the means of the fabric as purchased or after five and ten launderings (Figure 2, page 10). Laundering had no effect upon the treated 50/50 blend. Regardless of number of launderings, there were no significant differences among any of the means (Figure 2, page 10).

Analysis of the warp breaking strength of the 65/35 polyester/cotton blends by the interaction between number of launderings and fabric type showed that, when the same level of launderings were compared, there was no significant difference between the untreated and treated fabrics. Disregarding number of launderings, the untreated fabric tended to have higher breaking strength than the treated fabric (Figure 3, page 11). The effect of laundering upon the untreated 65/35 blend was an increase of warp breaking strength after laundering. The breaking strength means after laundering, regardless of number of launderings, were significantly different from the mean of the fabric as

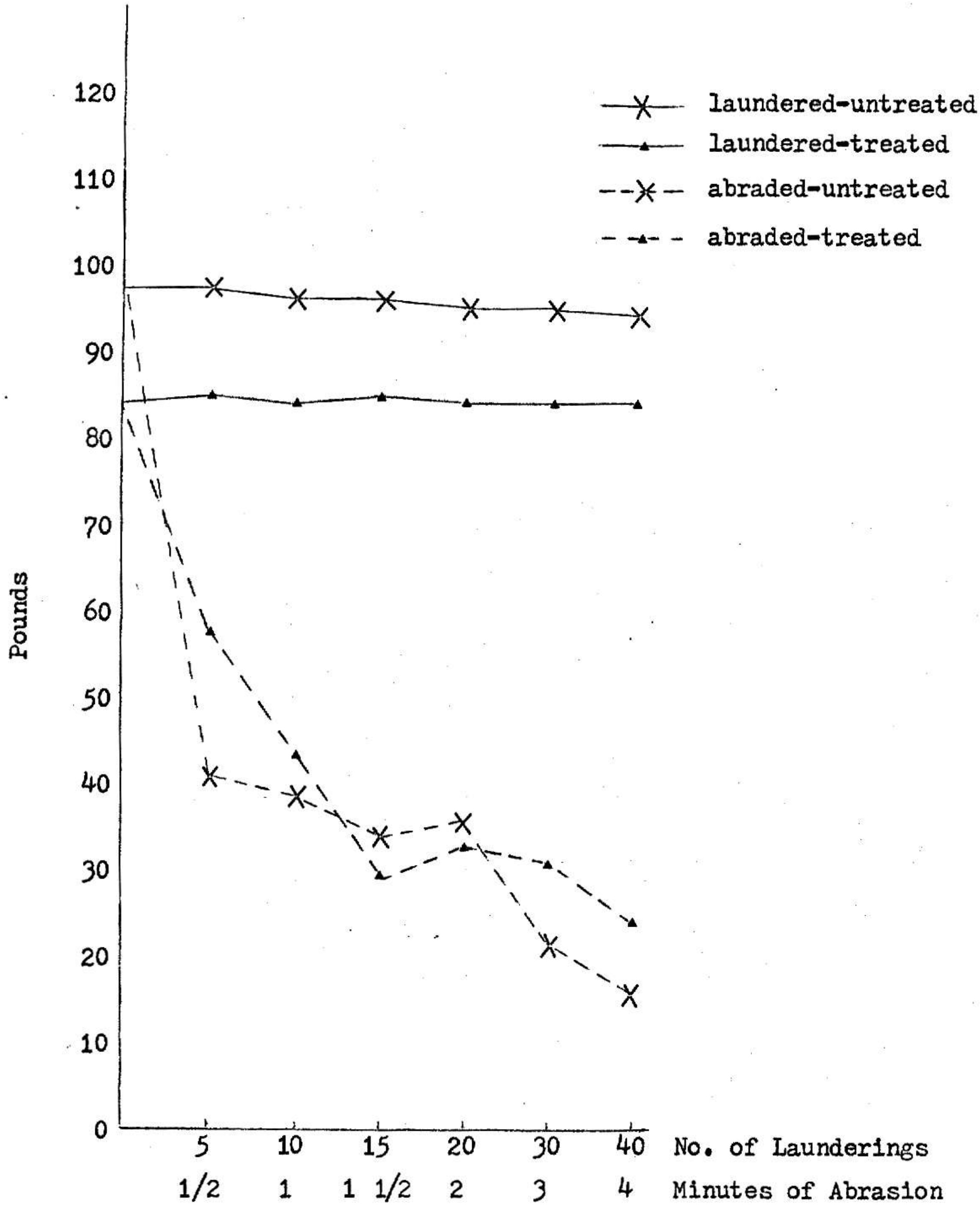

Figure 2. Warp Breaking Strength (in Pounds) of 50/50% Cotton/Polyester Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

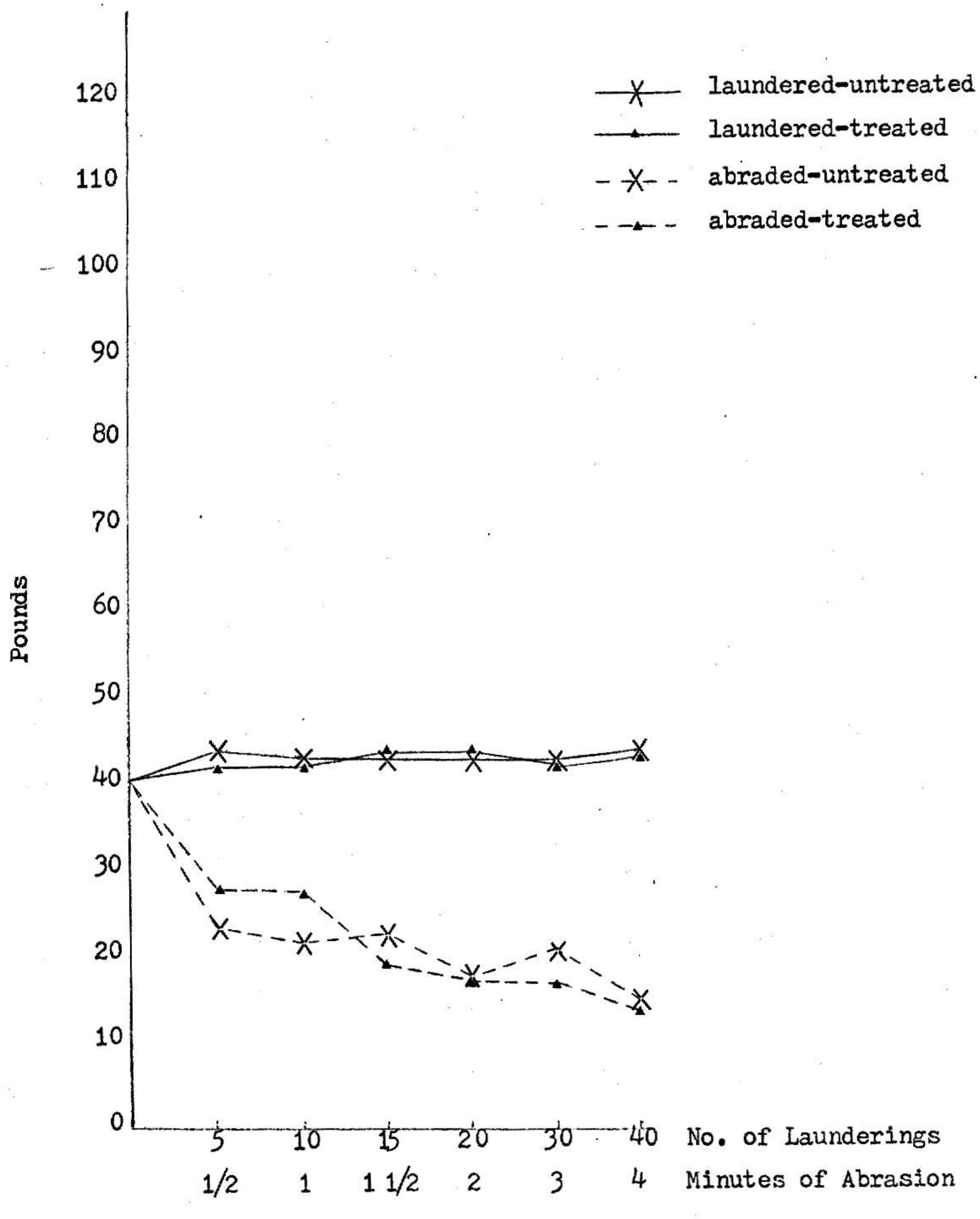

Figure 3. Warp Breaking Strength (in Pounds) of 65/35% Polyester/Cotton Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

purchased. After the initial effect of laundering, there was no further significant change (Figure 3, page 11). Laundering had no effect upon the warp breaking strength of the treated 65/35 blend. There were no significant differences among any of the means (Figure 3, page 11).

Accelerotor abrasion. Two-way analysis of variance using the F test for significance at the 95 percent level showed significant differences with all the variables; i.e. amount of abrasion time, fabric type, and the interaction between amount of abrasion time and fabric type (Table 2, page 7).

Analysis of warp breaking strength by the amount of abrasion time showed that abrasion caused the breaking strength to decrease. The breaking strength means after abrasion, regardless of amount of abrasion time, were significantly different from the mean of the fabrics as purchased. After the initial effect of abrasion, there was further significant change which followed a progressive order (Table 5, page 29).

Analysis of warp breaking strength by fabric type showed that in the matched pair of cotton fabrics the untreated fabric had a higher breaking strength than the treated fabric, and there was significant difference between them. There was no significant difference between the 50/50 cotton/polyester blends or between the 65/35 polyester/cotton blends (Table 6, page 29).

Analysis of all cotton warp breaking strength by the interaction between amount of abrasion time and fabric type showed that, when the same levels of abrasion time were compared, the untreated fabric had a higher warp breaking strength than did the treated fabric. The untreated and treated fabrics were significantly different from each other until after two minutes of abrasion, and then there was no significant difference between them (Figure 1, page 8). The effect of abrasion on the warp breaking strength of the untreated cotton was gradual decrease in breaking strength with increase in amount of abrasion time. The means after abrasion, regardless of amount of time, were significantly different from the means of the fabric as purchased. After the initial effect of abrasion, there was further significant change which followed a progressive order (Figure 1, page 8). A decrease in warp breaking strength was the effect of abrasion upon the treated cotton. The means after abrasion, regardless of amount of time, were significantly different from the mean of the fabric as purchased. After the initial effect, there was no further significant change (Figure 1, page 8).

Analysis of the warp breaking strength of the 50/50 cotton/polyester blends by the interaction between amount of abrasion time and fabric type showed that, when the same levels of abrasion time were compared, the untreated and treated fabrics were significantly different from each other until after one minute of abrasion, and then there were no significant differences between them (Figure 2, page 10). The effect of abrasion upon the untreated 50/50 blend was the gradual decrease of warp breaking strength with the increase of abrasion time. The means after abrasion, regardless of amount of time, were significantly different from the mean of the fabric as purchased. After the initial effect, there was further significant change which followed a progressive order (Figure 2, page 10). Gradual decrease in warp breaking strength as abrasion time increased was also the effect upon the treated 50/50 blend. The means after abrasion, regardless of amount of time, were significantly different from the mean of the fabric as purchased. After the initial effect, there was further significant change, which followed a progressive order (Figure 2, page 10).

Analysis of the warp breaking strength of the 65/35 polyester/cotton blends by the interaction between amount of abrasion time and fabric type showed that, when the same levels of abrasion time were compared, there were no significant differences between the untreated and treated fabrics (Figure 3, page 11). The effect upon the warp breaking strength of the untreated 65/35 blend was a decrease in breaking strength after abrasion. The breaking strength means after abrasion, regardless of amount of abrasion time, were significantly different from the mean of the fabric as purchased. After the initial effect of abrasion, there was no further significant change (Figure 3, page 11). The effect upon the warp breaking strength of the treated 65/35 blend was a decrease in breaking strength after abrasion. The breaking strength means after abrasion, regardless of amount of abrasion time, were significantly different from the mean of the fabric as purchased. After the initial effect of abrasion, there was further significant change which followed a progressive order (Figure 3, page 11).

<u>Filling Breaking Strength</u>

<u>Laundering</u>. Three-way analysis of variance using the F test for significance at the 95 percent level showed significant differences

with the following variables: number of launderings, fabric type, interaction between detergent and fabric type, and interaction between number of launderings and fabric type. Significant differences were not found with detergent, interaction between detergent and number of launderings, or for the interaction of detergent x number of launderings x fabric type (Table 3, page 16).

Analysis of filling breaking strength by number of launderings showed that laundering caused the breaking strengths to increase. The breaking strength means after laundering, regardless of number of launderings, were significantly different from the mean of the fabrics as purchased. After the initial effect of laundering, there was no further significant change (Table 10, page 33).

Analysis of filling breaking strength by fabric type showed that in every matched pair of fabrics, the untreated fabric has a higher breaking strength than the treated fabric, and there was significant difference between them (Table 11, page 33).

Analysis of all cotton filling breaking strength by the interaction between number of launderings and fabric type showed that the untreated fabric had higher breaking strength than the treated fabric; and the untreated cotton means were significantly different from the treated cotton means, regardless of number of launderings (Figure 4, page 17). The effect of number of launderings upon the untreated cotton was first an increase in breaking strength after five launderings and then a decrease in breaking strength with continued launderings. The breaking strength means of the fabric as purchased and after ten launderings, regardless of number of launderings, were significantly

Table 3. Analysis of Variance of Filling Breaking Strengths of Laundered Fabrics

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F-Value
Detergent Type	1	7.099	7.099	1.390
Number of Launderings	6	269.349	44.891	8.791*
Fabric Type	5	30182.371	6036.473	1182.148*
Detergent Type x Number of Launderings	6	20.881	3.480	0.682
Det. Type x Fabric Type	5	68.261	13.652	2.674*
Number of Launderings x Fabric Type	30	369.930	12.331	2.415*
Det. Type x No. of Launderings x Fabric Type	30	177.664	5.922	1.160
Error	336	1715.737	5.106	
Total	419	32811.297		

Table 4. Analysis of Variance of Filling Breaking Strengths of Abraded Fabrics

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F-Value
Amount of Abrasion Time	6	7309.672	1218.279	45.368*
Fabric Type	5	22273.860	4454.770	165.892*
Amount of Abrasion Time x Fabric Type	30	1487.064	49.569	1.846*
Error	168	4511.387	26.853	
Total	209	35581.984		

*Significant at 95% level.

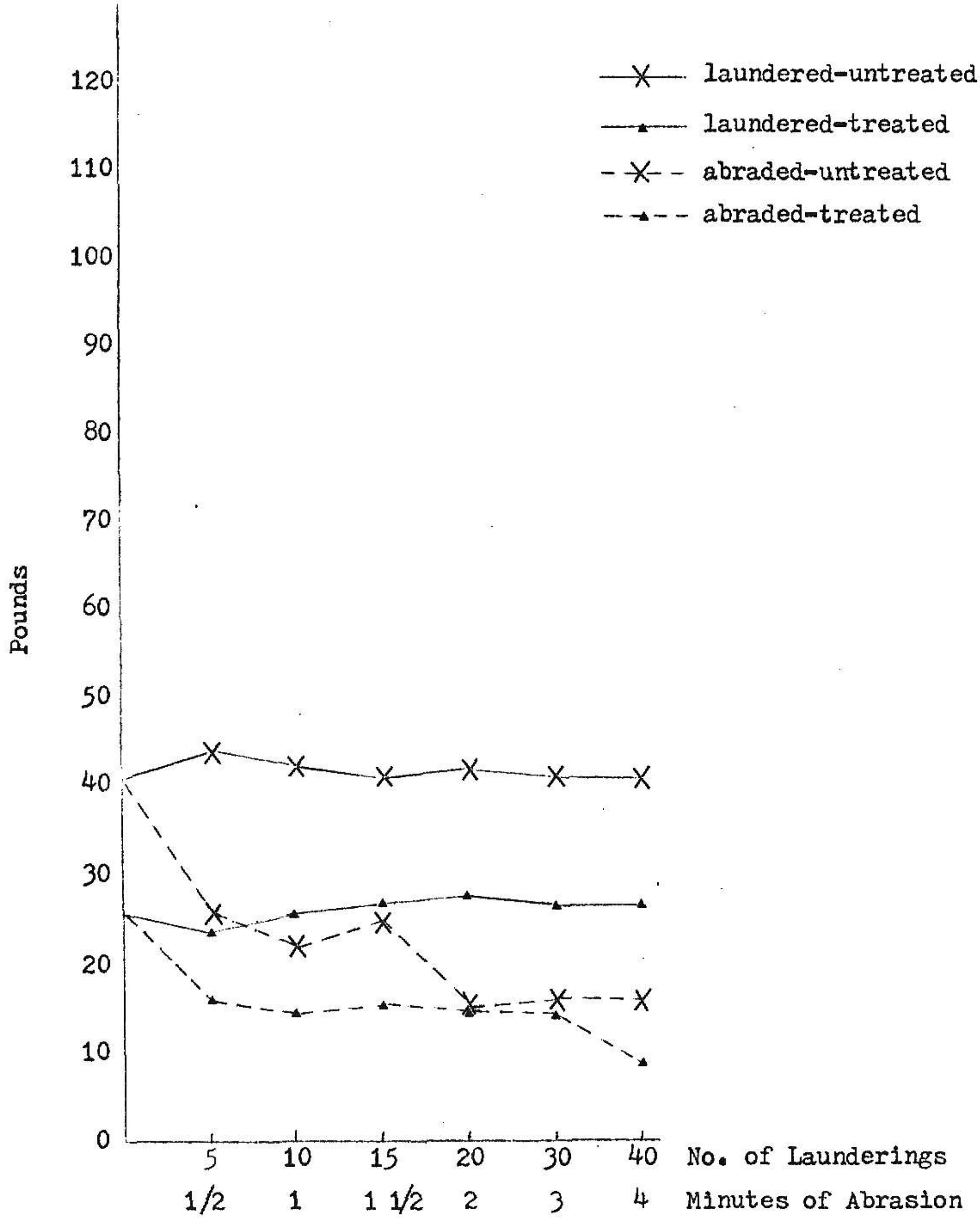

Figure 4. Filling Breaking Strength (in Pounds) of 100% Cotton Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

different from the breaking strength mean after five launderings. After the effect of ten launderings, there was no further significant change (Figure 4, page 17). The effect of laundering upon the treated cotton was first a nonsignificant decrease in filling breaking strength after five launderings and then an increase in breaking strength with continued launderings. The breaking strength means of the fabric after ten launderings, regardless of number of launderings, were significantly different from the mean breaking strength after five launderings. After the effect of ten launderings, there was no further significant change (Figure 4, page 17).

Analysis of the filling breaking strength of the 50/50 cotton/polyester blends by the interaction between number of launderings and fabric type showed that, regardless of number of launderings, the untreated fabric had higher breaking strength than the treated fabric. Except for the mean of the untreated fabric as purchased, the breaking strength means of the untreated 50/50 blend were significantly different from the breaking strength means of the treated 50/50 blend (Figure 5, page 19). The effect of laundering upon the untreated 50/50 blend was an increase of breaking strength after laundering. The breaking strength means after laundering, regardless of number of launderings, were significantly different from the mean of the fabric as purchased. There were no other significant differences among the means except for a difference between the mean after twenty launderings and the means after forty launderings, for which there is no explanation (Figure 5, page 19). Laundering had no effect upon the filling breaking strength

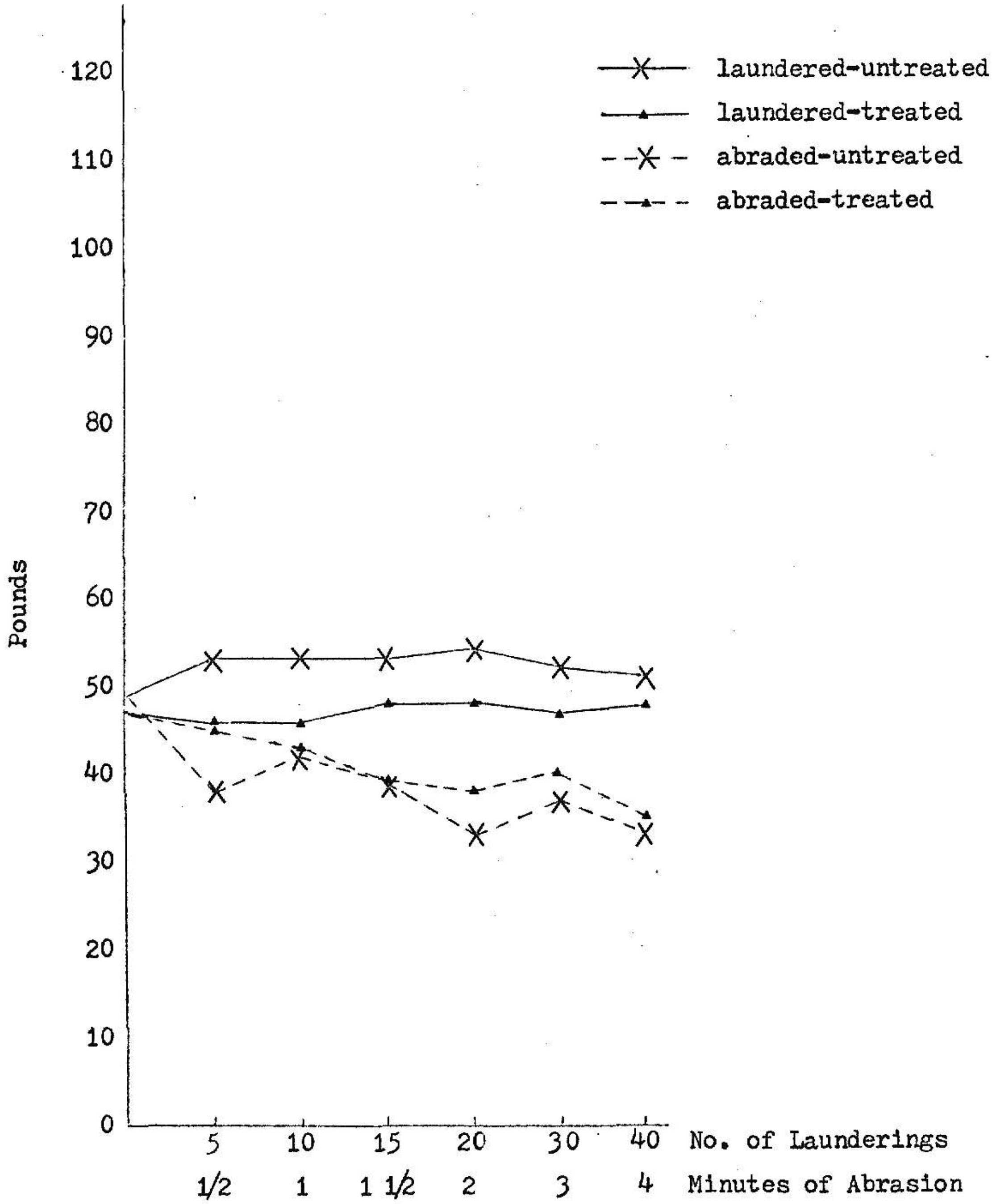

Figure 5. Filling Breaking Strength (in Pounds) of 50/50% Cotton/Polyester Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

of the treated 50/50 blend. There were no significant differences among any of the means (Figure 5, page 19).

Analysis of the filling breaking strength of the 65/35 polyester/cotton blends by the interaction between number of launderings and fabric type showed that when the same level of launderings were compared, the untreated fabric always had the higher mean. At the same time, there was no significant difference between the untreated and the treated fabrics when the same level of launderings were compared (Figure 6, page 21). The effect of laundering upon the untreated 65/35 blend was an increase of filling breaking strength after laundering. The breaking strength means after laundering, regardless of number of launderings, were significantly different from the mean of the fabric as purchased. After the initial effect of laundering, there was no further significant change (Figure 6, page 21). The effect of laundering upon the filling breaking strength of the treated 65/35 blend was identical to that upon the filling breaking strength of the untreated 65/35 blend (Figure 6, page 21).

<u>Accelerotor abrasion</u>. Two-way analysis of variance using the F test for significance at the 95 percent level, showed significant differences with all the variables; i.e. amount of abrasion time, fabric type, and the interaction between amount of abrasion time and fabric type (Table 4, page 16).

Analysis of filling breaking strength by the amount of abrasion time showed that abrasion caused the breaking strengths to decrease. The breaking strength means after abrasion, regardless of amount of abrasion time, were significantly different from the mean of the

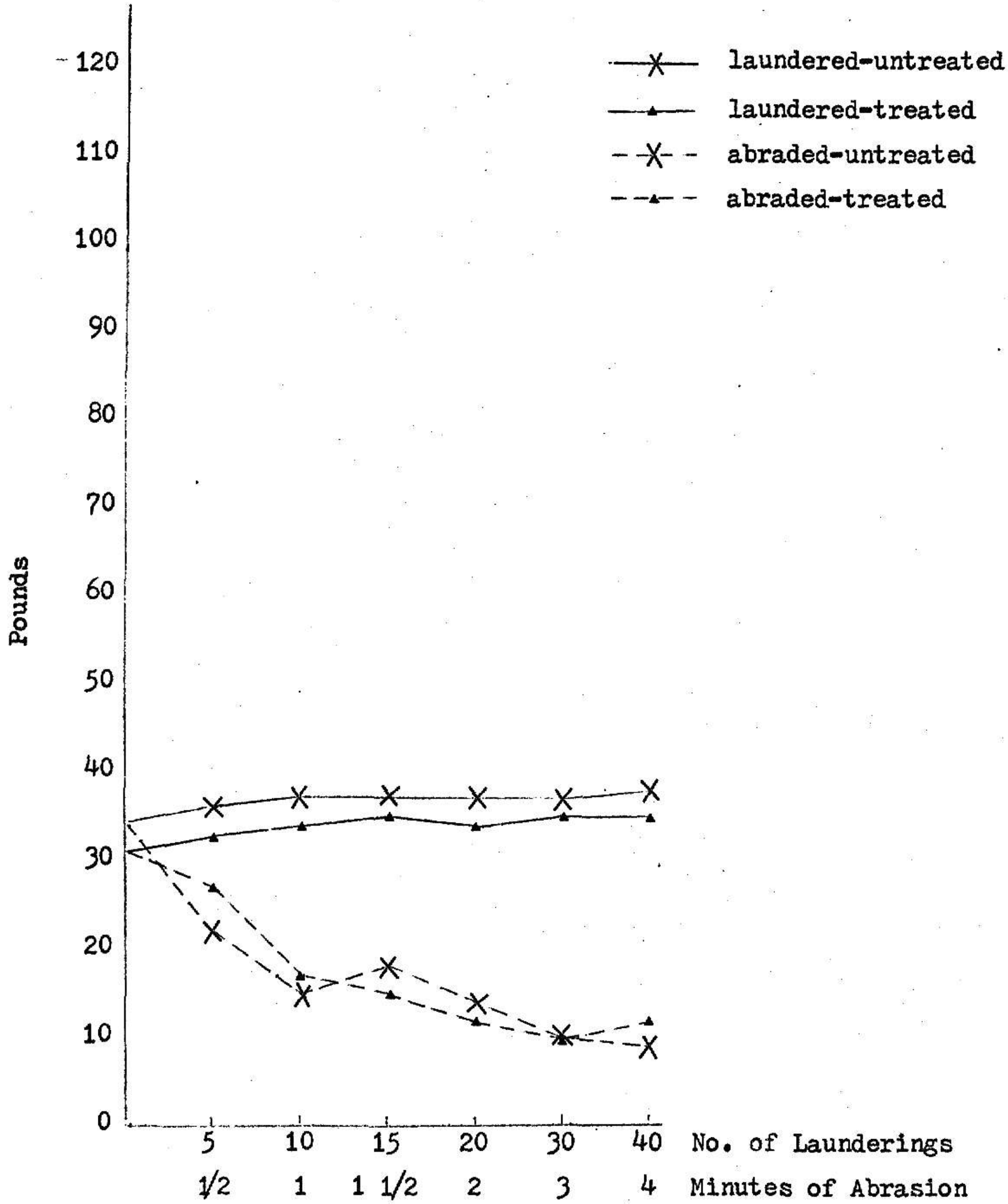

Figure 6. Filling Breaking Strength (in Pounds) of 65/35% Polyester/Cotton Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

fabrics as purchased. After the initial effect of abrasion, there was further significant change which followed a progressive order (Table 10, page 33).

Analysis of filling breaking strength by fabric type showed that in the matched pair of cotton fabrics the untreated fabric had a higher breaking strength than the treated fabric, and there was significant difference between them. There was no significant difference between the 50/50 cotton/polyester blends or between the 65/35 polyester/cotton blends (Table 11, page 33).

Analysis of the all cotton filling breaking strength by the interaction between amount of abrasion time and fabric type showed that, when the same levels of abrasion were compared, there was a tendency for the untreated fabric to have a higher filling breaking strength than did the treated fabric. The untreated and treated fabrics were significantly different from each other until after two minutes of abrasion, and then there were no further significant differences between them (Figure 4, page 17). The effect of abrasion upon the filling breaking strength of the untreated cotton was a decrease in breaking strength after abrasion. The breaking strength means after abrasion, regardless of amount of abrasion time, were significantly different from the mean of the fabric as purchased. After the initial effect of abrasion, there was further significant change which followed a progressive order (Figure 4, page 17). The effect of abrasion upon the filling breaking strengths of the treated all cotton fabric was identical to that upon the filling breaking strengths of the untreated all cotton fabric (Figure 4, page 17).

Analysis of the filling breaking strength of the 50/50 cotton/polyester blend by the interaction between amount of abrasion time and fabric type showed that, when the same levels of abrasion time were compared, there were no significant differences between the untreated and treated fabrics. When the same levels of abrasion time were compared, there was a tendency for the mean of the treated fabric to be higher than the mean of the untreated fabric (Figure 5, page 19). The effect of abrasion upon the filling breaking strength of the untreated 50/50 blend was a decrease in breaking strength after abrasion. The breaking strength means after abrasion, regardless of amount of abrasion time, were significantly different from the mean of the fabric as purchased. After the initial effect of abrasion, there was further significant change which followed a progressive order (Figure 5, page 19). The effect of abrasion upon the filling breaking strength of the treated 50/50 blend was similar to that upon the filling breaking strength of the untreated 50/50 blend. The only exception was that the mean of the treated fabric as purchased was only significantly different from the means of the last four levels of abrasion time (one and one-half minutes through four minutes), whereas the mean of the untreated fabric as purchased was significantly different from the means after abrasion, regardless of amount of abrasion time (Figure 5, page 19).

Analysis of the filling breaking strength of the 65/35 polyester/cotton blends by the interaction between amount of abrasion time and fabric type showed that, when the same levels of abrasion time were compared, there were no significant differences between the untreated and treated fabrics (Figure 6, page 21). The effect upon the filling breaking strength of the untreated 65/35 blend was a decrease in breaking strength after abrasion. The breaking strength means after abrasion, regardless of amount of abrasion time, were significantly different from the mean of the fabric as purchased. After the initial effect of abrasion, there was further significant change which followed a progressive order (Figure 6, page 21). The effect upon the filling breaking strength of the treated 65/35 blend was a decrease in breaking strength after abrasion. The means after one minute of abrasion, regardless of amount of abrasion time, were significantly different from the means of the fabric as purchased or after one-half minute of abrasion. After one minute of abrasion, there was further significant change which followed a progressive order (Figure 6, page 21).

SUMMARY AND RECOMMENDATIONS

Summary

Generally, the effects from laundering and from Accelerotor abrasion were different. Increasing the number of launderings had no effect upon the warp breaking strength and caused only a slight initial increase in the filling breaking strength; but increasing the amount of abrasion time caused the breaking strength to decrease in both warp and filling (Table 5, page 29 and Table 10, page 33). In fact, abrasion affected the fabrics so harshly that with every one of the six fabrics the breaking strength mean after only the first level of abrasion (one-half minute) was lower than the means after laundering, regardless of number of launderings. This difference was as great as 37 pounds with the untreated cotton warp (Figure 1, page 8) and as low as one pound with the treated 50/50 cotton/polyester filling (Figure 5, page 19).

With the laundering data there were significant differences between the matched untreated and treated fabrics but with the Accelerotor abrasion data these differences were not significant. Abrasion seemed to eventually cancel out the significant difference between the untreated and treated 50/50 cotton/polyester and between the untreated and treated 65/35 polyester/cotton (Tables 6, page 29 and 11, page 33).

Whenever there was a significant difference between the matched untreated and treated fabrics, the untreated fabrics tended to be stronger. There was a tendency for the treated fabrics to resist any effect from laundering, especially in the warp; but the untreated fabrics did not show this same tendency. Even though the treated fabrics were weaker in the beginning than the corresponding untreated fabrics, the treated fabrics were more resistant to laundering change. This trend did not appear with the fabrics after abrasion.

Another apparent trend was that as the percentage of polyester in the fabrics increased, the difference between the untreated and treated fabrics attributable to finish decreased. The corresponding untreated and treated fabrics were more alike in the polyester blends, probably because of the smaller amount of cotton for the resins to affect.

Abrasion also seemed to have this same effect of overcoming the differences attributable to finish. After two minutes of abrasion, there were no significant differences between any of the corresponding untreated and treated fabrics.

Recommendations

Further research comparing the effect of laundering and the effects of Accelerotor abrasion should be done. The samples used in this study's abrasion tests were too large and would catch on the rotor. One recommendation is that smaller samples be used in the abrasion tests. Another recommendation is that some other method of evaluation be used instead of breaking strength. Evaluation by appearance is suggested.

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APPENDIX

Table 5. Warp Breaking Strength (in Pounds) after Laundering by Number of Launderings and after Abrasion by Amount of Abrasion Time

Number of Launderings	Mean	Amount of Abrasion Time (in minutes)	Mean
No significant differences		0	61.95
		1/2	30.93
		1	27.88
		1 1/2	23.45
		2	21.06
		3	17.36
		4	14.03
LSD*	--	LSD*	3.78

Table 6. Warp Breaking Strength (in Pounds) after Laundering by Fabric Type and after Abrasion by Fabric Type

Laundering		Abrasion	
Fabric Type	Mean	Fabric Type	Mean
50/50% cotton/polyester, untreated	95.73	50/50% cotton/polyester, untreated	42.91
50/50% cotton/polyester, treated	84.29	50/50% cotton/polyester, treated	40.62
100% cotton, untreated	63.12	100% cotton, untreated	24.15
100% cotton, treated	43.41	65/35% polyester/cotton, treated	23.53
65/35% polyester/cotton, untreated	42.97	65/35% polyester/cotton, untreated	23.40
65/35% polyester/cotton, treated	42.22	100% cotton, treated	13.95
LSD*	0.68	LSD*	3.50

*Significant at 95% level.

Nonsignificant groupings connected by line.

Table 7. Warp Breaking Strength (in Pounds) of 100% Cotton Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

No. of Launderings and Fabric Type	Mean	Amount of Abrasion Time (in minutes) and Fabric Type	Mean
0, untreated	65.56	0, untreated	65.56
5, untreated	64.29	0, treated	43.32
15, untreated	63.54	1, untreated	24.70
20, untreated	62.75	1/2, untreated	24.46
40, untreated	62.43	1 1/2, untreated	22.04
10, untreated	61.65	2, untreated	14.80
30, untreated	61.60	1/2, treated	13.64
10, treated	44.65	1 1/2, treated	10.66
40, treated	43.92	1, treated	10.10
30, treated	43.69	4, untreated	8.80
0, treated	43.32	3, untreated	8.72
15, treated	43.11	2, treated	7.90
5, treated	43.10	4, treated	6.28
20, treated	42.04	3, treated	5.78
LSD*	1.80	LSD*	9.27

*Significant at 95% level.

Nonsignificant groupings connected by line.

Table 8. Warp Breaking Strength (in Pounds) of 50/50% Cotton/Polyester Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

No. of Launderings and Fabric Type	Mean	Amount of Abrasion Time (in minutes) and Fabric Type	Mean
0, untreated	97.32	0, untreated	96.76
5, untreated	96.76	0, treated	83.70
10, untreated	96.01	1/2, treated	57.96
15, untreated	95.62	1, treated	42.56
20, untreated	95.45	1/2, untreated	40.78
30, untreated	95.10	1, untreated	39.24
40, untreated	93.91	2, untreated	35.94
15, treated	85.01	1 1/2, untreated	34.18
5, treated	84.83	2, treated	32.84
10, treated	84.40	3, treated	30.64
20, treated	84.13	1 1/2, treated	28.90
40, treated	84.09	4, treated	23.80
30, treated	83.84	3, untreated	21.58
0, treated	83.70	4, untreated	15.86
LSD*	1.80	LSD*	9.27

*Significant at 95% level.

Nonsignificant groupings connected by line.

Table 9. Warp Breaking Strength (in Pounds) of 65/35% Polyester/Cotton Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

No. of Launderings and Fabric Type	Mean	Amount of Abrasion Time (in minutes) and Fabric Type	Mean
40, untreated	43.91	0, treated	41.34
5, untreated	43.70	0, untreated	41.02
10, untreated	43.43	1, treated	28.22
20, untreated	43.36	1/2, treated	27.58
15, treated	42.78	1/2, untreated	23.60
30, untreated	42.70	1 1/2, untreated	23.12
15, untreated	42.65	1, untreated	22.48
40, treated	42.60	3, untreated	20.70
20, treated	42.59	1 1/2, treated	19.36
30, treated	42.21	2, untreated	17.72
10, treated	42.00	2, treated	17.18
5, treated	41.92	3, treated	16.74
0, treated	41.44	4, untreated	15.18
0, untreated	40.85	4, treated	14.26
LSD*	1.80	LSD*	9.27

*Significant at 95% level.

Nonsignificant groupings connected by line.

Table 10. Filling Breaking Strength (in Pounds) after Laundering by Number of Launderings and after Abrasion by Amount of Abrasion Time

Number of Launderings	Mean	Amount of Abrasion Time (in minutes)	Mean
20	40.25	0	37.76
30	40.10	1/2	28.99
15	40.09	1	25.85
40	40.04	1 1/2	25.33
10	39.73	3	21.29
5	39.49	2	21.08
0	37.76	4	18.89
LSD*	0.81	LSD*	2.62

Table 11. Filling Breaking Strength (in Pounds) after Laundering by Fabric Type and after Abrasion by Fabric Type

Laundering		Abrasion	
Fabric Type	Mean	Fabric Type	Mean
50/50% cotton/polyester, untreated	52.24	50/50% cotton/polyester, treated	41.01
50/50% cotton/polyester, treated	46.98	50/50% cotton/polyester, untreated	38.59
100% cotton, untreated	41.68	100% cotton, untreated	23.05
65/35% polyester/cotton, untreated	36.48	65/35% polyester/cotton, treated	17.63
65/35% polyester/cotton, treated	33.87	65/35% polyester/cotton, untreated	17.35
100% cotton, treated	26.56	100% cotton, treated	15.98
LSD*	0.75	LSD*	2.43

*Significant at 95% level.

Nonsignificant groupings connected by line.

Table 12. Filling Breaking Strength (in Pounds) of 100% Cotton Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

No. of Launderings and Fabric Type	Mean	Amount of Abrasion Time (in minutes) and Fabric Type	Mean
5, untreated	43.91	0, untreated	41.24
10, untreated	41.89	1/2, untreated	26.66
20, untreated	41.50	0, treated	25.82
0, untreated	41.24	1 1/2, untreated	25.14
30, untreated	41.11	1, untreated	22.24
40, untreated	41.07	1/2, treated	16.32
15, untreated	41.06	1 1/2, treated	15.98
20, treated	27.73	3, untreated	15.84
30, treated	27.47	4, untreated	15.62
40, treated	27.44	1, treated	15.48
15, treated	26.93	2, treated	14.78
10, treated	26.32	3, treated	14.70
0, treated	25.82	2, untreated	14.62
5, treated	24.22	4, treated	9.28
LSD*	1.98	LSD*	6.42

*Significant at 95% level.

Nonsignificant groupings connected by line.

Table 13. Filling Breaking Strength (in Pounds) of 50/50% Cotton/Polyester Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

No. of Launderings and Fabric Type	Mean	Amount of Abrasion Time (in minutes) and Fabric Type	Mean
20, untreated	53.59	0, untreated	48.50
5, untreated	53.34	0, treated	46.74
10, untreated	53.33	1/2, treated	44.54
15, untreated	53.20	1, treated	43.22
30, untreated	52.25	1, untreated	41.90
40, untreated	51.47	3, treated	39.92
0, untreated	48.50	1 1/2, treated	39.04
40, treated	47.70	1 1/2, untreated	38.82
15, treated	47.60	2, treated	38.34
20, treated	47.50	1/2, untreated	38.12
30, treated	47.49	3, untreated	37.28
0, treated	46.74	4, treated	35.04
10, treated	46.24	2, untreated	32.88
5, treated	45.73	4, untreated	32.64
LSD*	1.98	LSD*	6.42

*Significant at 95% level.

Nonsignificant groupings connected by line.

Table 14. Filling Breaking Strength (in Pounds) of 65/35% Polyester/ Cotton Fabrics, Untreated and Treated, after each Series of Launderings and each Level of Abrasion

No. of Launderings and Fabric Type	Mean	Amount of Abrasion Time (in minutes) and Fabric Type	Mean
40, untreated	37.65	0, untreated	33.64
30, untreated	37.10	0, treated	30.64
20, untreated	37.10	1/2, treated	26.68
15, untreated	36.95	1/2, untreated	21.58
10, untreated	36.61	1 1/2, untreated	17.58
5, untreated	36.44	1, treated	17.42
30, treated	35.10	1 1/2, treated	15.40
15, treated	34.96	1, untreated	14.82
40, treated	34.91	2, untreated	14.10
20, treated	34.07	4, treated	11.88
10, treated	33.96	2, treated	11.72
0, untreated	33.64	3, untreated	10.34
5, treated	33.37	3, treated	9.64
0, treated	30.64	4, untreated	9.36
LSD*	1.98	LSD*	6.42

*Significant at 95% level.

Nonsignificant groupings connected by line.

A COMPARISON OF THE EFFECT OF LAUNDERING AND OF ACCELEROTOR ABRASION ON THE BREAKING STRENGTH OF MATCHED UNTREATED AND TREATED FABRICS

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AN ABSTRACT OF A MASTER'S THESIS

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The development of reliable, consistent and rapid laboratory analysis methods that can predict in-service fabric performance is important so problems and promising treatments can be determined promptly. This need has become increasingly important with the development of "wash-and-wear" and "durable press" fabrics.

This study compared the effects of multiple laundering with the effect of laboratory wear, i.e. Accelerotor abrasion, on matched untreated and treated cotton and cotton/polyester blends, as measured by breaking strength. Data indicate that the effects from laundering and from Accelerotor abrasion are different. Laundering had no effect on the warp breaking strength and caused slight increase in the filling breaking strength; abrasion caused both warp and filling breaking strength to decrease.

Data also indicate that the untreated cotton and cotton/polyester blends tended to be stronger than the treated versions of the same fabric, but there was also a tendency for the treated fabrics to be more resistant to the effect of laundering. All the fabrics seemed to have poor abrasion resistance, and after two minutes of abrasion there were no significant differences between any of the corresponding untreated and treated fabrics. Moreover, data indicate that as the percentage of polyester in the fabrics increased, the difference attributable to finish between the corresponding untreated and treated fabrics decreased.