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A Study on the Strength Properties of Various Buttons Used in Garments

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ABSTRACT

Auxiliary materials are as important as fabric, which is the main material of a garment. One of the most important auxiliary materials is the button. There are different types of buttons, made of different materials, with different numbers of holes in different sizes. The breaking strength of the button determines the performance characteristics of the buttons during usage. In this study, commonly used types of buttons were investigated and the breaking strength values of different buttons were measured. The results show that the breaking strength of buttons is related to the number of holes in the button, the size of the sewing thread, and the fabric type. However, the effects of button size and button material were found to be statistically insignificant.

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KEYWORDS

Button, button types, button performance, button breaking strength, garment, apparel

1. INTRODUCTION

The development of fashion accessories has gained momentum with the fast-growing fashion consciousness. A garment is an ensemble of fabric and accessories. It is possible to say that the garment remains incomplete without accessories [1]. While fabrics are the main component of the garment, an equally important component is the accessories that make up the complete assembly [2]. Auxiliary materials and accessories are indispensable elements, especially in the garment industry. They are as important as the fabric, which is the main material of a garment. They complete the garment or utility item in terms of functionality or aesthetics. One of the most important auxiliary materials is the button, which has been known since pre-Christian times. They are commonly used in the ready-to-wear industry to fasten garments, but they are also an important accessory as they add aesthetic value to garments.

A button is a small, usually round disk usually attached to a garment to close an opening or decorate it. Buttons come in a variety of materials, colors and shapes. They can be made from a variety of materials, including natural materials such as antler, bone, hard fiber, pearl, horn, ivory, shell, vegetable ivory and wood or synthetic materials such as celluloid, glass, metal, bakelite and plastic. The choice of buttons depends on the clothing style, cost and care of the garments [1, 3, 4]. Natural materials offer buttons with some variability in color, pattern, possibly in size and shape, at a higher cost, while man-made materials are more uniform and less expensive [5].

Buttons usually have a round shape. The diameter of the button is measured by the same system regardless of the type of button or material. The unit for measuring the diameter is the line (L). One line is equal to 1/40 of an inch [3]. Buttons that can be sewn usually have 2 or 4-holes [6] and they are sewn onto garments using the single-thread chain stitch, lockstitch or simulated hand stitch. The single-

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thread chain stitch provides an insecure button attachment [5]. For this reason, the lockstitch is preferred for children's garments.

Important properties of buttons are color fastness, compressive strength, dry cleaning solubility (durability), heat resistance, impact resistance, mildew resistance, launderability, tensile strength and water resistance [3].

The button strength test shows how tightly the button is attached to the fabric. For this purpose, by attaching special apparatus to conventional tensile strength devices or special test devices for buttons strength are used. In addition, other important mechanical strength tests are performed on buttons. The "fatigue test" measures the performance of the button after it has been subjected to a certain load. The "button leg separation strength test" shows the structural deformation of the button [7].

There is some research on the performance characteristics of auxiliary materials such as zippers [8,9], linings [10,11], sewing threads [12,13,14] and interlinings [15,16]. However, as a result of the literature review, no systematic study has been conducted to investigate and compare the effects of different variables on the breaking strength of buttons for apparel products with specific types, sizes and numbers of holes. Therefore, the aim of this paper is to investigate and compare the effects of button material, button size, number of buttonholes, fabric type and sewing thread count on the breaking strength of buttons. It is thought that this study will lead the way in conducting studies to investigate the properties of buttons.

2. MATERIAL AND METHOD

2.1 Material

In this study, 28 buttons with different sizes and materials were used. Polyester, wooden and coconut buttons, commonly used for garments, with 2 and 4-holes in different sizes were selected. The buttons used in the study and their characteristics are shown in Table 1. Different fabrics and sewing threads were used to determine the effects of other parameters. The properties of the fabrics and sewing threads are given in Tables 2 and 3.

2.2 Method

Sample preparation

The Lewis 200-1 button sewing machine was used to sew the buttons to the fabric. Parallel stitches were used when sewing the buttons on. During sewing, the number of needle penetrations was kept constant for all trials. All buttons were first sewn to the same fabric (F1) using the same sewing thread (ST1) to determine the effect of button size, button type and number of holes on the strength of the buttons. To determine the other effects (sewn fabric and sewing thread) a cotton fabric with similar fabric construction (plain) and lower fabric weight (F2) and a polyester core-spun thread with higher thread count (ST2) were used.

Table 1. Properties of the buttons

Button code	Type	Size (L)	Number of holes	Average breaking strength (N)
B1	PES	>40	4	29,43
B2	PES	40	4	27,83
B3	PES	36	4	26,93
B4	PES	28	4	26,20
B5	PES	24	4	25,60
B6	PES	20	4	26,23
B7	PES	18	4	25,53
B8	PES	16	4	25,53
B9	PES	14	4	21,77
B10	PES	40	2	18,47
B11	PES	32	2	18,87
B12	PES	24	2	19,73
B13	PES	22	2	20,00
B14	Wooden	40	4	26,95
B15	Wooden	36	4	26,90
B16	Wooden	28	4	25,70
B17	Wooden	18	4	25,37
B18	Wooden	32	2	16,33
B19	Wooden	20	2	18,97
B20	Coconut	40	4	28,45
B21	Coconut	18	4	26,30
B22	Coconut	40	2	15,90
B23	Coconut	32	2	18,10
B24	Coconut	28	2	19,03
B25	Coconut	24	2	20,17
B26	Coconut	20	2	20,17
B27	Coconut	18	2	19,63
B28	Coconut	14	2	21,20

Table 2. Properties of the fabrics

Fabric code	Material	Construction	Density (thread/cm)		Mass per unit area (g/m^2)
			Warp	Weft	
F1	Cotton	Plain	24	17	134
F2	Cotton	Plain	64	42	60

Table 3. Properties of sewing threads

Sewing thread code	Type	Thread count		Number of plies
		Tex	TKT	
ST1	Polyester-polyester core-spun	30	100	2
ST2	Polyester-polyester core-spun	60	50	3

Button breaking strength test

In order to determine the performance of sewn buttons during usage, a button-breaking strength test was conducted by Prowhite Button Strength Measurement Device (Figure 1). In this test, the sewn button is placed between two jaws and the strength of the button is measured by applying tensile and rotational forces (Figure 2).

Statistical evaluation

Evaluation of the test results was assessed by analysis of variance (ANOVA) using SPSS software. To determine if the group means were significantly different, the significance level (p-value) was determined. In this analysis, only those cases that had statistical significance beyond the 5% level ($0 \leq p \leq 0,05$) were considered significant. Independent samples t-test and Student-Newman-Keuls tests were performed to determine whether the effects of button size, button type, number of holes and other parameters on the breaking strength of the buttons were statistically significant.

Figure 1. Button strength measuring device and the jaws

Figure 2. Execution of the test

3. RESULTS AND DISCUSSION

In this part, the effects of button size, number of holes, button type, fabric type and sewing thread count on the breaking strength of buttons were evaluated respectively. When testing the breaking strength of individual buttons, the breakage always occurred in the sewing thread or fabric.

3.1. Effect of button size

4-hole buttons

The breaking strength values of 4-hole buttons are shown in Figure 3. To determine the effects of button size on PES and wooden buttons, the SNK multiple comparison test was used (Table 4), while the independent samples t-test was used to evaluate coconut buttons (Table 5).

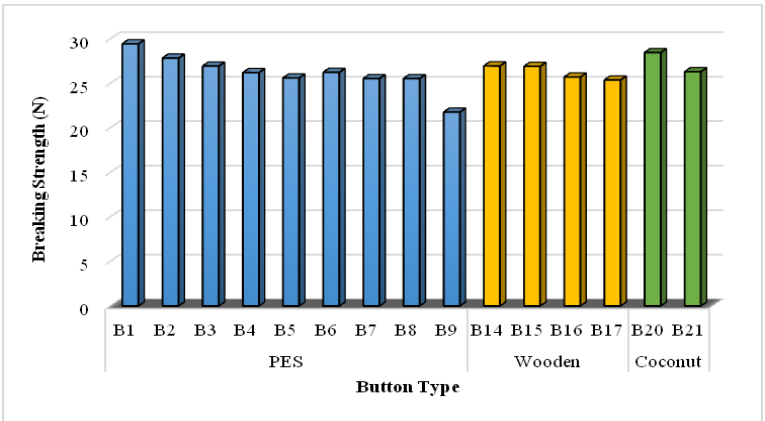

Figure 3. Breaking strength values of 4-hole buttons

Table 4. Effect of button size on 4-hole buttons

Button code	N	Subset		Button code	N	Subset
		1	2			1
B9	3	21,7667		B17	3	25,3667
B7	3	25,5333	25,5333	B16	3	25,7000
B8	3	25,5333	25,5333	B15	3	26,9000
B5	3	25,6000	25,6000	B14	3	26,9500
B4	3	26,2000	26,2000			
B6	3	26,2333	26,2333			
B3	3	26,9333	26,9333			
B2	3		27,8333			
B1	3		29,4333			
Sig.		**1,000**	**0,153**	**Sig.**		**0,542**

Table 5. Significance values of independent sample t-test

Parameter	Button type	Button size	Significance
Effect of button size	Coconut 4-hole buttons	B20 (40 L) B21 (18 L)	0,383
Effect of button size	Wooden 2-hole buttons	B18 (32 L) B19 (20 L)	0,272
Effect of number of holes	PES buttons (24 L)	B5 (4-hole) B12 (2-hole)	0,042*
	PES buttons (40 L)	B2 (4-hole) B10 (2-hole)	0,003*
	Coconut buttons (18 L)	B21 (4-hole) B27 (2-hole)	0,044*
	Coconut buttons (40 L)	B20 (4-hole) B22 (2-hole)	0,047*
Effect of fabric type	PES buttons (B12)	F1 F2	0,001*
	Coconut buttons (B25)	F1 F2	0,003*
Effect of sewing thread size	PES buttons (B12)	ST1 ST2	0,013*
	Coconut buttons (B25)	ST1 ST2	0,003*

* Significant according to p=0,05 significance level.

Figure 3 shows that the breaking strength values of all button types are higher for larger sizes, while they are lower for smaller sizes. Within the group, the PES button with a diameter of >40 L (B1) has the highest value, while the PES button with a diameter of 14 L (B9) has the lowest value. It can be seen that the value of breaking strength tends to decrease for all button types with smaller diameters. However, the statistical test results show that the differences between the results are insignificant, except for the results of the buttons having the largest and smallest button sizes (B1, B2 and B9).

2-hole buttons

The breaking strength values of 2-hole buttons are shown in Figure 4. To determine the effects of button size on PES and coconut buttons, the SNK multiple comparison test was conducted (Table 6), while the independent samples t-test was used to evaluate wooden buttons as indicated in Table 5.

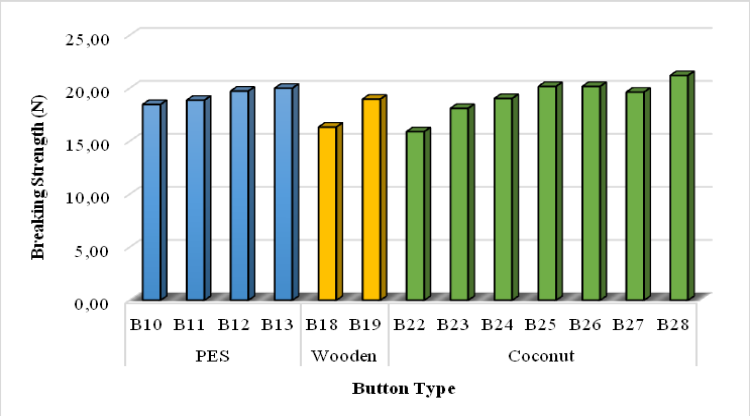

Figure 4. Breaking strength values of 2-hole buttons

Table 6. Effect of button size on 2-hole buttons

Button code	N	Subset		Button code	N	Subset
		1	2			1
B22	3	15,9000		B10	3	18,4667
B23	3	18,1000	18,1000	B11	3	18,8667
B24	3	19,0333	19,0333	B12	3	19,7333
B27	3	19,6333	19,6333	B13	3	20,0000
B25	3	20,1667	20,1667			
B26	3	20,1700	20,1700			
B28	3		21,2000			
Sig.		**0,061**	**0,190**	**Sig.**		**0,730**

As can be seen from Figure 4, in contrast to the 4-hole buttons, the button with the smallest diameter was found to have the highest value for breaking force and as the button size decreased, the mean value for breaking force increased. However, the difference between the results is not statistically significant for PES and wooden buttons.

3.2. Effect of button type

To determine the effect of button type, buttons made of different materials but with the same diameter and number of holes, were selected. The breaking strength values of 2-hole buttons made of different materials with the same diameter (32 L) and 4-hole buttons made of different materials with the same diameter (18 L) are shown in Figure 5. To determine the effect of button type on breaking strength, the SNK multiple comparison test was performed, which is given in Table 7.

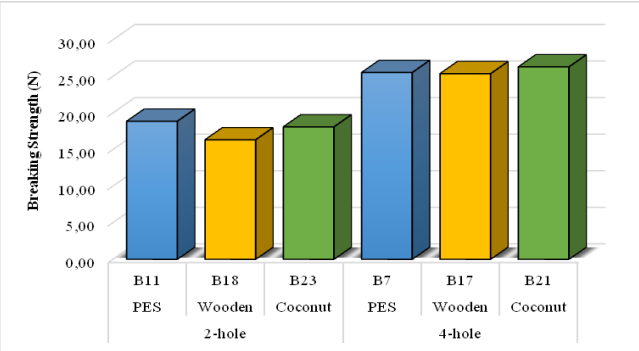

Figure 5. Breaking strength values of 2-hole and 4-hole buttons with same diameter

Table 7. Effect of button type on 2-hole and 4-hole buttons with the same diameter

Button code	N	Subset
		1
Wooden (B18)	3	16,3333
Coconut (B23)	3	18,1000
PES (B11)	3	18,8667
Sig.		**0,466**
Wooden (B17)	3	25,3667
PES (B7)	3	25,5333
Coconut (B21)	3	26,3000
Sig.		**0,913**

According to the results, the wooden buttons had the lowest breaking strength values among the other buttons with the same diameter and number of holes. However, no significant differences were found between the button types in the breaking strength values of the buttons (see Table 7). Since the gripper jaw completely grips the button, the breakage always occurs in sewing thread or fabric during the button breaking strength test.

3.3. Effect of number of holes

To investigate the effect of the number of holes on the strength of the buttons, PES buttons with the same diameters, 24 L and 40 L, and coconut buttons 18 L and 40 L were compared respectively. The effect of the number of holes on the breaking strength values is shown in Figure 6, and the statistical analysis is given in Table 5.

When considering the effect of the number of holes on the breaking strength of PES and coconut buttons of the same diameter, it was found that the average value of breaking

strength was higher for buttons with 4-holes and the differences between the values were statically significant. During the sewing process, the number of needle penetrations was kept constant for buttons with 2 and 4-holes. Thus, for 2-hole buttons, the number of needle penetration per hole is twice as higher than 4-hole buttons. For this reason, fabrics sewn with 2-hole buttons have more damage at the puncture points in the fabric structure than fabrics sewn with 4-hole buttons. Moreover, in 4-hole buttons, the button and fabric are connected at four different points, whereas 2-hole buttons have a 2-point connection. It is believed that the higher number of connections between fabric and button positively affects breaking strength test results.

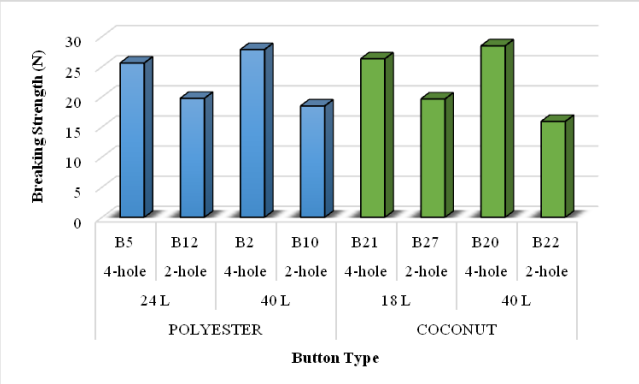

Figure 6. Breaking strength values of buttons with the same diameters in different numbers of holes

3.4. Effect of other parameters

3.4.1. Effect of sewn fabric

For examining the effect of fabric type on the button breaking strength, 2-hole buttons (PES and Coconut buttons) with a diameter of 24 L were sewn using two different fabrics (F1 and F2) with the same sewing thread (ST1). The test results and statistical analysis of the samples are given in Figure 7 and Table 5, respectively.

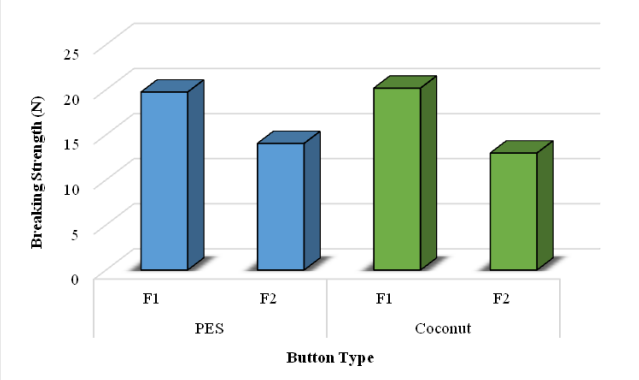

Figure 7. Breaking strength values of 2-hole buttons (24 L) sewn with different fabrics

When sewing 2-hole buttons of the same diameter to different fabrics, it was found that the heavier and tighter fabric had the highest strength, as expected. Since a tight and heavier fabric is used, the fabric is less damaged, so the button-breaking strength is also higher. This indicates that the type of fabric affects the strength values of the buttons.

3.4.2. Effect of sewing thread

To investigate the effect of sewing thread size on button breaking strength, 2-hole buttons (PES and Coconut buttons) with the same diameter (24 L) were sewn using two different sewing threads (ST1 and ST2). The test results and statistical analysis of the samples are given in Figure 8 and Table 5, respectively.

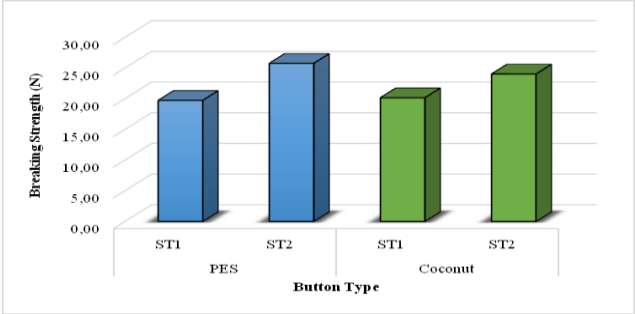

Figure 8. Breaking strength values of 2-hole buttons (24 L) sewn with different sewing threads

As shown in Figure 8, the sewing thread affects the breaking strength of the buttons. In both PES and coconut buttons, the buttons sewn with 60 tex thread showed higher durability than those sewn with 30 tex. The strength of the buttons sewn with thicker threads was higher than the strength values of the buttons sewn with thinner threads.

4. CONCLUSION

Buttons, which can be considered an essential material for garments, are used to fasten or decorate the garment. They are commonly used in the ready-to-wear industry, where they are needed for fastening, but they are also an important accessory, as they add aesthetic value to the garments for which they are used. The properties expected of buttons vary depending on their use. In particular, testing the strength of buttons is critical for garment use, performance and durability.

This study examined button types commonly used in the apparel industry, and the objective was to measure the breaking strength of the different buttons. This study focused on the physical parameters such as button size, button type, number of holes, and the effect of these parameters on the breaking strength of buttons. For this purpose, 28 buttons with different structural properties (size, type and number of holes) were supplied to study the breaking strength of the buttons.

In this study, the following results were found:

- A slight decrease in the breaking strength values of 2-hole buttons was observed with increasing button size. Opposite to that, higher values were obtained for 4-

hole buttons, however, the effect of button size was found to be statistically insignificant.

- The breaking strength values of 4-hole buttons are statistically higher than those of 2-hole buttons. This is due to the fact that fabrics sewn with 2-hole buttons show more damage at the puncture points in the fabric structure than fabrics sewn with 4-hole buttons. Moreover, in 4-hole buttons, the number of connection points between button and fabric is twice as higher than 2-hole buttons. The higher the number of connections between fabric and button, the higher the breaking strength.
- When the strength values of buttons made of different materials owing the same diameter are studied, it is found that wooden buttons have the lowest strength values. Moreover, the material type is not statistically significant.
- It is noted that the fabric plays a significant role in the breaking strength of the buttons. The fabric with a higher weight and tighter structure has a higher strength.
- The sewing thread count used in button sewing has a significant effect on the breaking strength of the button. As the thread count (tex) increases, the breaking strength values also increase.

The results indicate that the breaking strength of buttons is related to the number of holes in the button, the size of the sewing thread and the type of fabric. Therefore, this result can be considered in the selection of buttons according to their aesthetic or functional properties.

According to the literature review, there is no specific study on the strength properties of buttons. In future studies, the scope of the work can be further expanded by using a different number of fabrics and sewing threads. This study will lead the way in conducting studies to investigate the properties of buttons.

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