Impact of Various Stitch Classes and Seam Types on Seam Strength

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ABSTRACT

The longevity of apparel can be increased by choosing suitable types of fabric, thread and seam class. Basic choices include type, thread, cloth, and seam. Components of clothing stability seam strength, strength efficiency, puckering, slippage, boldness, and appearance are factors that affect seam quality. Any completed garment product's strength and seam look are both utilitarian and aesthetically pleasing features. Both are thought to be crucial elements that affect how long a garment will last. The primary focus of this study report is the effect of stitch type and seam type on the stipulated SPI values for seam strength in cotton denim fabric. To assess the fabric's seam strength a tensile strength tester was used. In this study, four distinct seam types lapped seam, bound seam, flat seam, and superimposed seam with a stitch density of 11 stitches per inch (SPI) on denim fabric are assessed for seam strength utilizing stitch types 301, 401, and 602. The outcome demonstrated that these elements have an impact on the garments' overall seam performance. For the same SPI, stitch class 602 has a stronger seam than other stitch classes. A prominent textile company called Mamiya-OP (Bangladesh) Ltd. provided a laboratory for testing the numerous seam section samples that were made for this study.

Key words: Stitch, Stitch density, Seam, Seam Strength, Seam performance.

INTRODUCTION

One of the crucial elements and a fundamental prerequisite in the creation of clothing is the seam. Customers primarily assess seam quality based on how the seam looks and how durable it is after use and care instructions. On completed fabrics, a variety of seam and stitch styles can be used, each with a unique impact on the strength, quality, and functionality of the seam. A more thorough examination of the ways in which different factors affect seam performance can be obtained through an analysis of seam performance. During product development and production, manufacturers typically assess the quality of the seams. The strength of the seam is influenced by numerous variables. The type of fabrics, threads, stitch type, kind of seam, sewing conditions, and upkeep of the seam all affect how well the seam looks and functions.

Given that sewing thread holds together the great majority of a garment's seams, it is crucial to understand that sewing thread and other factors bear 50% of the blame for the garment's performance. An essential component of the clothing production process is sewing thread. The apparel business uses a wide range of sewing threads. Cotton and polyester fibers make up the bulk of sewing threads used in the apparel industry. Many factors influenced the quality of seams such as Speed, Needle, Thread and Fabric. It was discovered that in order to create quality seams, these elements still interact fundamentally. Even though a lot of procedures have been created up to this point, none have been as effective as sewing. Using a needle to move sewing materials, such as textiles, inside and out is called stitching. In addition to being used to sew relatively rigid materials like woven fabrics, different stitches and stitch types are also employed to knit fewer flexible products like knitted suits and garments. Sewing threads remain an indispensable element in the textile industry, even with the recent advancements in automation of general setup. New research conducted by manufacturers has eradicated the errors that stem from the stitching threads.

The arrangement of sewing threads in a certain repetitive unit is called a stitch. Stitches are the joints formed by the interlocking of two pieces of cloth that are sewn together, as well as the interloping of threads. A garment's functional and aesthetic performance can be determined in part by its stitches. Important performance factors like their longevity, comfort, and attractiveness are dictated by the garment's design and intended use, the kind of fabric utilized, and the placement and function of the stitches. The selection of stitches is also influenced by cost factors. The American Society for Testing and Materials (ASTM) has classified stitches into six major classes (ASTM D6193-97), each differing in their construction and application. These classes are based on the number of threads and needles used, the formation of the stitch, and the resultant seam type.

Class 100 (Chain Stitches): These stitches are formed by a single thread looped back on itself. They are known for their extensibility and are commonly used in hems and garment assembly where stretch is required. However, they generally offer lower seam strength compared to other classes.

Class 200 (Hand Stitches): Mimicking traditional hand stitches, these are not widely used in industrial sewing due to their time-consuming nature and lower strength and are mainly used for decorative purposes.

Class 300 (Lock Stitches): They are widely used due to their high seam strength and versatility, suitable for most types of garments and they are formed by interlocking two threads.

Class 400 (Multi-thread Chain Stitches): These are more complex chain stitches that use multiple threads to form a strong, flexible seam. They are commonly used in high-stress areas such as seams in jeans and activewear.

Class 500 (Overedge Stitches): Overedge stitches, also known as overlock or serge stitches, enclose the raw edges of the fabric, preventing fraying. They are essential for knit fabrics and provide moderate seam strength.

Class 600 (Covering Chain Stitches): These stitches are used for knit garments, providing extensive coverage of the seam and high elasticity. They are ideal for activewear and garments requiring stretch.

A seam is formed by a sequence of stitches that connect two or more layers of a material. When producing an article, materials are joined or assembled via seams. Applying a number of stitches or different types of stitches to a single or several material thicknesses creates a seam. Aesthetics is enhanced by straight, orderly, smooth, and even seams that are not twisted, ropey, or wavy. Each of these stitch classes can be combined with different seam types to achieve the desired properties in a garment. British Standard 3870 lists eight different kinds of seams.

- Class 1 (superimposed seam)
- Class 2 (lapped seam)
- Class 3 (bound seam)
- Class 4 (flat seam)
- Class 5 (decorative seam)
- Class 6 (edge neatening Seam)
- Class 7 (applied)
- Class 8 (others-single ply constructions)

Superimposed Seams are the most common type, where two or more layers of fabric are stitched together along the same line. This type offers a balance of strength and flexibility, making it suitable for various garment parts, including side seams and sleeves. Lapped Seams involve overlapping two or more fabric layers and stitching through them. They are typically used in jeans and other heavy-duty garments due to their high strength**.** Bound Seams enclose the raw edges of the fabric within a binding strip, providing a neat finish and moderate strength. They are commonly used in the construction of edges and hems. Flat Seams join the fabric edges together, creating a smooth, flat seam that minimizes bulk. They are often used in undergarments and sportswear, where comfort and flexibility are crucial. A decorative seam consists of a row or rows of stitches sewn through one or more pieces of fabric. Edge-Finish Seams are used to finish the raw edges of the fabric, preventing fraying while providing a clean appearance. They are typically used in hems and seams that are visible on the exterior of the garment. Applied Seam class relates to the addition of separate items to the edge of a garment part and is similar to the lapped seam. To construct seam class 8, only one piece of fabric is involved. The commonest seam types in this class are the belt loop as used on jeans, raincoats, etc.

The load necessary to break a seam is referred to as seam strength. This gauges a seems resilience and strength. Sewing thread and fabric are the two components of every seam. As a result, seam strength must come from the breaking of thread or fabric, or more frequently, both at the same time. The force needed to rupture the seam is typically higher than the force needed to break the unsewn fabric. Factors that determine the strength of a seam are fabric type, weight, strength, durability, thread fiber type, construction, and size, stitch and seam construction and stitches per Inch (A&E).

There are two primary ways to assess seam quality: functionally and aesthetically [1]. Seam's functions as seam strength and seam efficiency were discussed on other studies [2]. Many research on seam quality that focuses on aesthetic performance has also been conducted [3]. Seam puckering and seam damage were the top priority to concentrate. The seam is a crucial component of most everyday clothing items. Sewing techniques are used to create a seam with the goal of meeting all the demands placed on it by various clothing product end users [4] [5]. When body parts are used, washed, or dry cleaned, seams are also subject to abrasion. It is anticipated that seams will be resistant to abrasion, washing, and/or dry cleaning. The consumer's body's sensory systems (hand, eye) must also meet specific aesthetic requirements. At the point of sale of clothing, a flawless seam is necessary to ensure customer satisfaction. The seam's varying degrees of boldness can serve a variety of functions as design elements and have an impact on the garment's look [6]. A garment product's durability depends on its overall seam quality, which also influences its sale ability along with customer satisfaction with wear and care instructions [7]. Based on the specifications of a seam from the perspective of the customer, the garment industry evaluates seam quality using a variety of metrics. The level of seam functionality or aesthetics required also differs according on how the clothing will be used. In contrast, bridal clothing prioritizes aesthetic performance above everything else [8]. A well-made gown should be aesthetically pleasing to the wearer; the wearer's appearance and design significance are crucial. It is crucial to take into account the overall harmony of the essential fabric qualities, sewing thread properties, and sewing condition parameters employed for improved seam quality [9]. All of these elements combine to produce the seam line's attractive and functional performance [10]. The previous study included a variety of techniques to measure the following aspects of seam quality: seam strength, seam efficiency, slippage, elongation, damage, puckering, and boldness [11]. The load necessary to break a seam is referred to as seam strength. This gauges a seems resilience and strength. A seam connects two pieces of woven fabric together, and rupture eventually happens at or close to the seam lines if tangential force is applied to the seam line [12]. Studies have shown that, in most cases, the force needed to break the unsewn fabric is smaller than the load needed to rupture the seam. Numerous studies have used the ASTM 1683-04 standards to determine seam strength [13]. These standards express the value of seam strength in terms of maximum force (in Newton N) to cause a seam specimen which is measured by the following equation,

$S_s = KS_b$, Where:

S_s = Sewn Seam Strength (N)

K = Constant equal to 1000 (SI units)

S_b = Observed Seam Breaking Force (N)

There have been experiments conducted on the seam quality of fabrics intended for clothing. The seam quality was assessed in accordance with ASTM standards. One of the key factors in determining a seam's design prominence is its seam boldness, a dimension that previous researchers were unable to investigate. As a result, their research on seam quality is constrained, dispersed, and infrequently comprehensive enough. Very little research has been done up to this point on seam quality that takes both its practical and aesthetic performance into account [14]. Undoubtedly, a study that takes into account the seams' functional and aesthetic performance will advance our understanding of the total seam quality of clothing articles. When certain sewing thread sizes and densities are applied to specific types of cloth, apparel engineers will be able to more accurately assess the quality of apparel items with the aid of knowledge about the overall quality of the seams [15]. This will make it easier for the garment engineers to plan ahead and maintain quality control throughout the manufacturing process.

This study examined the performance of superimposed seam, lapped seam, bound seam and flat seam as well as the impact of different stitch classes (301, 401, and 602) and stitch density (SPI 11) on seam strength. To evaluate the result tensile strength tester is used and a comparative analysis is established. This research could be a means to assess the seam strength of denim fabric.

MATERIALS AND METHODS

Materials

100% cotton denim fabric and 100% staple spun polyester thread were used for this research. The twill weave fabric with GSM 415,70 EPI and 45 PPI was used. The sewing thread with two ply with 20 TPI, the linear density was 60 Tex and Ticket number 50. The elongation percentage of the sewing thread was 10-15%.

Selection of the Stitch types and seam types

In this research, three classes of stitches class 301, 401 and Class 602 were used for the study. The Sewing of denim fabric can originate with different density levels, but in this research study, the one stitch level was considered, with 11 SPI. Depending on the type of fabric used, the amount of tension exerted on the seam, and whether the seam is a decorative aspect of the design, many types of seam constructions are utilized. Superimposed, lapped, bonded, flat, edge-finished, and ornamental seams are a few of the most often utilized seam styles. Four types of seams superimposed seams, lapped seams, bound seams and flat seams were chosen for this investigation.

Sewing machine selection

The sewing machine used in this study was commercially produced by “JUKI” company. Sewing of the specimens or samples formation was done in the garment’s lab of the Mamiya-OP (Bangladesh) Ltd, Chattogram. The sewing machines used in this study were the Industrial lock stitch machine (301), Single needle chain stitch machine (401) and Multi Thread Chain Stitch (602).

Methods

The tensile strength of the fabric was tested on textile tensile strength tester Model KG-300 by a strip test method. The (ASTM D-1683-04) test method was used to measure the tensile strength of the fabric. The test method uses the strip test procedure to measure the breaking of the seam. The tensile strength machine model KG-300 was used to test the sample, also called pendulum type tester with a low elongation percentage, such as paper, rubber, plastic and textile material for tensile strength and elongation percentage. The load of three categories according to the maximum loading (2000N/3000N/4000N) can be selected and used for different materials. Speed is (1-600) mm/min, Clamp space (25-500) mm, and Test space is 600 mm. Elongation percentages can be indicated with a dial gauge. CRE (Constant Rate of Extension) method of tensile testing machine is capable of performing several mechanical tests of yarn and fabrics such as tear, peel, seam strength, breaking strength, grab strength, grip strength, tensile strength, elongation at break etc. The machine with a jaws separation rate of 305610 mm/min (12.0 6 0.5 in/min) was used, standard testing method (ASTM D-1683-04) for failure/rapture in a sewn seam of woven fabrics, followed by ISO 13935 specifications was used to determine the seam strength, when the force is applied perpendicularly to the seam. The ISO 13935 specifies the method known as the strip test.

The sample of (10× 10) cm was cut from the base fabric and created for the testing of the specimens. Total 12 specimens were considered for this research. Specimens were cut for testing from both directions with seam allowance of 1 inch. After applying three types of stitches with different seam classes at 11 SPI the specimen was conditioned in the testing facility for two hours at a temperature of 21° +/- 1C (70° +/- 2F) and a relative humidity of 65% +/- 2%. The machine gauge was then adjusted to 25 mm (3 in.) using tension load cells that had a capacity of 100–1000 lbs. Afterwards, 30.5 cm (12 in.) per minute was chosen as the machine's speed. When the seam raptured, the machine was stopped manually and the breaking force on the semi-circle scale was recorded manually. The same procedure was used for several trials for seam strength of all four categories of seam. Seam efficiency was measured by the following formula: Seam efficiency (%) = (Seamed fabric tensile strength / Un-seamed fabric tensile strength) × 100.

Figure 1: Tensile strength tester

RESULTS AND DISCUSSION

Effect of Stitch Class on Superimposed Seam

Similar to the example above, three distinct stitch classes were used to create the bound seam, which was sewn at a stitch density of 11. As seen in Table 1, this blend conducts three bound seam experiments. On bound seams, numerous trials were conducted, and a mean value was found. The words FTS (fabric tearing strength) were employed in this table because fabric breaking phenomena was occasionally seen when testing bound seams. This element involves a number of variables, including the fabric's weight, the number of picks and ends per inch, the type of stitch, and the density of the stitch. However, Table 1 illustrates that the reason for this was the distinct type of stitch.

Table 1: Average seam strength of superimposed seam with different stitch classes.

Seam Type	Stitch density	Fabric Strength (N)	Stitch class	Seam Strength (N)	Seam Efficiency (%)
Superimposed Seam	11	891	301	420	47.13
			401	510	57.23
			602	560	62.85

The findings for the superimposed seam are displayed in the above figure. Seams in class 602 demonstrated maximum strength; in fact, in all of the tests conducted, seams did not break down in the fabric tearing strength. There was a variation in the strengths of classes 301 and 401. Class 401's seam strength was higher than class 301's at 11 SPI.

Effect of Stitch Class on Lapped Seam

These three distinct stitch classes were transmitted when sewing a lapped seam at stitch density 11. To get reliable data for all three types of seams employed in the study, several experimental trials were conducted repeatedly. In this testing phase, there are instances where the fabric breaks rather than the seam, demonstrating that the seam which is dependent on the type and density of the stitches is far more powerful than the fabric. Table 2 shows that lapped seams on their own had the greatest influence.

Table 2: Average seam strength of lapped seam with different stitch classes.

Seam Type	Stitch density	Fabric Strength (N)	Stitch class	Seam Strength (N)	Seam Efficiency (%)
Lapped Seam	11	891	301	460	51.62
			401	520	58.36
			602	540	60.60

The findings for the lapped seam are shown in the above figure. Seams in class 602 demonstrated maximum strength and class 301 showed minimum strength.

Effect of Stitch Class on Bound Seam

For bound seams, however, Table 3 shows varying seam strength and seam efficiency. After numerous testing's on bonded seams, a mean value was discovered. Because fabric breaking phenomena was occasionally observed when testing bound seams, fabric tearing strength was used in this table. The weight of the material, the number of picks and ends per inch, the type of stitch, and the stitch density are some of the variables that affect this element. This blend performs three bound seam experiments, as shown in Table 3.

Table 3: Average seam strength of bound seam with different stitch classes.

Seam Type	Stitch density	Fabric Strength (N)	Stitch class	Seam Strength (N)	Seam Efficiency (%)
Bound Seam	11	891	301	390	43.77
			401	470	52.74
			602	500	56.11

The bound seam results are displayed in the above figure. Seams in class 602 demonstrated maximum strength; in fact, in all of the tests conducted, seams did not break down in the fabric tearing strength. Class 401's seam strength was higher than class 301's at 11 SPI.

Effect of Stitch Class on Flat Seam

These three distinct stitch classes were transmitted when sewing a lapped seam at stitch density 11. To get reliable data for all three types of seams employed in the study, several experimental trials were conducted repeatedly. In this testing phase, there are instances where the fabric breaks rather than the seam, demonstrating that the seam which is dependent on the type and density of the stitches is far more powerful than the fabric. Table 4 shows that lapped seams on their own had the greatest influence.

Table 4: Average seam strength of flat seam with different stitch classes.

Seam Type	Stitch density	Fabric Strength (N)	Stitch class	Seam Strength (N)	Seam Efficiency (%)
Flat Seam	11	891	301	410	46.01
			401	490	54.99
			602	520	58.36

In flat seam the maximum seam strength was examined in stitch class 601 and the minimum in the stitch class 301.The seam efficiency was varied as the seam strength was different at 11 SPI.

Seam Strength and Efficiency Analysis

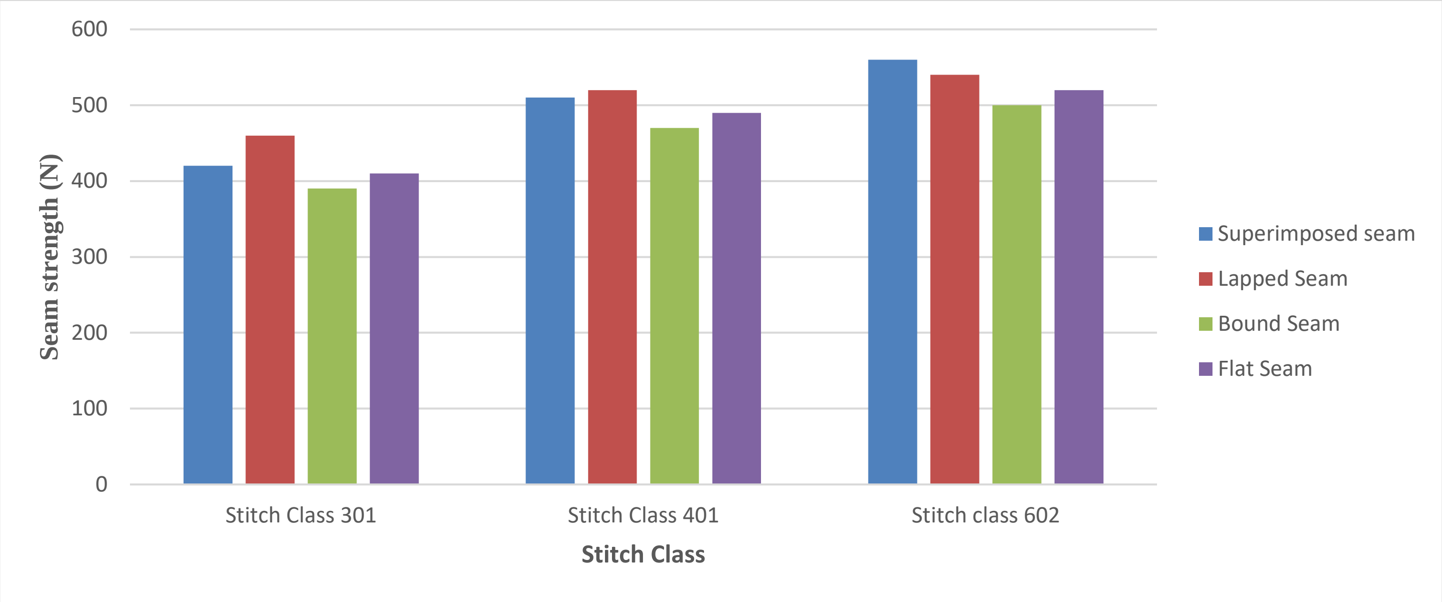

Figure 1: Seam strength analysis of different types of seams in the bar chart.

The findings for the bound and lapped seams are displayed in the above figure. The strength of the bound seam is lower for the same thread density than the lapped seam for various stitch classes. Bound seams are not as robust as lapped seams.

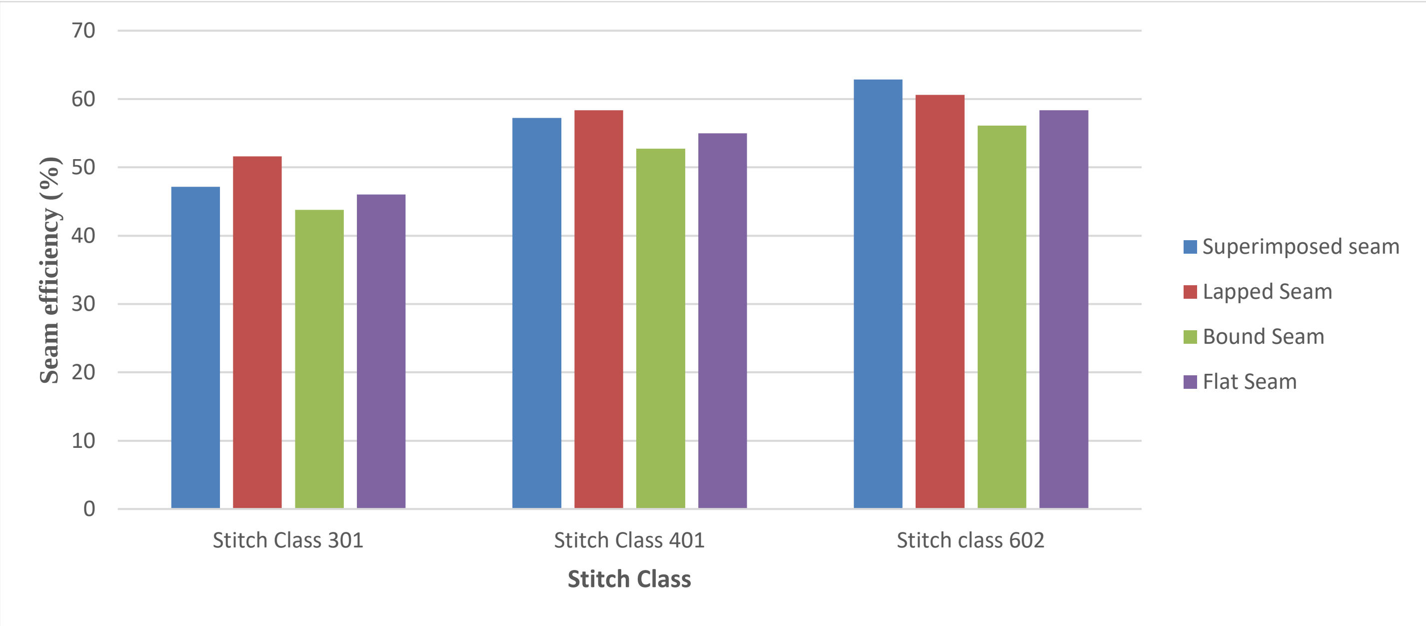

Figure 2: Seam efficiency analysis of different types of seams in bar chart.

The acquired results show how the seam strength varies depending on the type of stitch. The bound seam had the lowest average seam strength (390 N) and the lapped seam had the highest (460 N) for the single needle lock stitch. For chain stitch class 401, the seam strength was observed at 510 N for superimposed seam,520 N for lapped seam,470 N for the bound seam and 490 N for the flat seam. On the other hand, seam strength was noticed as 560 N,540 N,500 N and 520 N correspondingly, for superimposed seam, lapped seam, bound seam and flat seam. Overall, the stitch density of 11 SPI, seam strength was highest for stitch class 601, and the superimposed seam and lapped seam have more strength than the bound seam and flat seam. Figure 2 displays a similar pattern for seam efficiency as it does for seam strength. The highest seam efficiency was seen with class 301 lapped seams, class 401 lapped seams, and class 601 superimposed seams with a stitch density of 11 SPI. Thus, it is evident that seam strength is significantly influenced by stitch class and seam class. To achieve exceptional seam strength, it is crucial to maintain the stitch class and seam kinds properly.

CONCLUSION

Based on trial data, it was discovered that different seams under the same stitch type and SPI have varying effects on strength. Every stitch class individually nearly displayed an average strength increase. Individual stitching variables affect the seam strength of garments colored. The performance of clothing is mostly determined by the seam and stitch, in addition to other sewing-related elements. The seam quality is subjected to the seam strength, strength efficiency, puckering and appearance. Consumers evaluate the seam quality mainly based on the seam's appearance and its durability. It is important to minimize the loss in seam strength during sewing for a better seam strength realization Therefore, it is crucial to use the right stitching techniques when creating clothing. The strength of the bound seam is lower for the same thread density than the lapped seam for various stitch classes. Bound seams are not as robust as lapped seams. Compared to other stitch classes, stitch class 602 is the strongest and has the longest durability. The main limitation of this study is that only the 100% cotton denim fabric having a twill structure was used for the investigation. In the next research phase, the authors will investigate the possibilities of the seam strength prediction for different fabric structures of various fabrics and various stitch densities made with different natural and synthetic fibers.

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Conflict of Interest

Author has declared no conflict of interest of this research.

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