


# Evaluate the Strength of Denim Goods Using Different Washing Technique

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**How to cite this paper:** Ahamed, J., Mahmud, Md.F., Ahammed, M.F., Mia, R., Hasan, Md.Z., Khan, T.H., Limon, G.Q. and Shamim, A.Md. (2021) Evaluate the Strength of Denim Goods Using Different Washing Technique. *Journal of Materials Science and Chemical Engineering*, 9, 1-8.  
<https://doi.org/10.4236/msce.2021.93001>

**Received:** January 20, 2021

**Accepted:** March 5, 2021

**Published:** March 8, 2021

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## Abstract

Day by day, the demand and popularity of denim have increased. With the increase in demand for denim, washing has also increased. When we washed a piece of denim fabric, then its properties also changed. The properties are tensile strength, GSM, color fading, stiffness, abrasion resistance, moisture regain, etc. In this study, we conduct different washing processes on denim fabric such are Stonewash, Caustic wash, Acid wash, Normal wash, Pigment wash, Sandblasting, and Super whitewash. After washing, the properties of denim fabric have been analyzed especially strength. The tear and tensile strength were measured by ISO standard. From the above washing method, Normal & pigment wash showed good strength properties comparing with others.

## Keywords

Denim Fabric, Washing Treatment, Tear Strength, Tensile Strength, Normal Wash, Pigment Wash

## 1. Introduction

Denim is an extremely strong, stiff, and hard-wearing weaved fabric. Denim is a cotton and twill fabric that uses colored warp and white weft yarn and used for Jeans, work clothes, and casual wear [1] [2] [3]. Denim is usually dyed with indigo, vat, and sulphur dyes. Among these indigo shares is 67%. Indigo dyes are used for fashion dyeing in denim, fibers dyed with indigo aren't included in fiber-transfer examinations, remain surface dyeing. Denim garment (Jeans) washing is known together as the widely used finishing treatment that has vast

usage in textile sectors because of creating a special appearance and making fashionable and wear comfortable garments of at the moment world and commonly used [4] [5]. Without finishing treatments, a denim garment is uncomfortable to wear, because of its weaving and dyeing effects. For this, it essentially needs a finishing treatment to create it softer, smoother, and comfortable to wear performance.

In Bangladesh, the washing of clothes has increased considerably lately. It is one of the most important processes in the textile industry. Washing of clothes can remove soil, dirt, and infectious material from the fabric. A variety of wash procedures can be followed to enhance the unique look of clothes according to design requirements. Washing can be very helpful in making adequate progress in the RMG sector [6] [7] [8] [9].

Washing industrial clothes is one of the most important methods in the textile industry. Dust, soil, and contagious agents may be separated from clothes by cleaning industrial clothing. A variety of washing strategies can be adopted to boost the unique look of clothes according to mode requirements [10]. In our nations, the equipment used to change the look, comfort, and fashion of the apparel is readily available [11] [12]. Some of these textile washing methods were created for denim clothing, but are commonly used for a wide range of styles of clothing. The mills and fashion houses involved in garment processing are continuously searching for ways to achieve unique and new looks. The factories and design houses engaged in the manufacture of clothing are actively looking for fresh and exclusive looks.

The popularity of garments washing especially on denim garments within the global market has been increasing day by day [13] [14]. To satisfy up the fast change of current demands of consumers, technologists try and introduce new designs and fashion on denim garments by using different washing methods. The foremost commonly denim washing methods are bleach wash, acid wash, enzyme wash, normal wash, stone wash, etc. [15] [16] [17]. After washing with these washing processes, the strength of denim goods must be changed. Therefore, the effect of varied washing methods on the strength of denim goods is chosen for this work.

## 2. Experimental Details

### 2.1. Materials

The chemicals, bleaching powder, soda ash, potassium permanganate, caustic soda, hydrogen peroxide, softener, acetic acid, optical brightening agent, etc. used for washing purposes were obtained from an Indian supplier (Mark Indian) and were used without further purification. Commercially available denim fabrics were purchased from a local market (Bangladesh) for washing. The construction of denim fabric is given below:

#### **Denim:**

- Construction:  $80 \times 64/10 \times 9$ , indigo dyed denim fabric, GSM-225.

- Composition: 100% cotton twill left hand twill, weave 3/1.

## 2.2. Methodology

Firstly, we have collected the raw denim fabric from the local market. After that, we did several washing processes (**Figure 1**) like Stone Wash, Caustic Wash, Pigment Wash, Acid wash, Normal wash, Sand Blasting, Super White Wash, etc., and were checked all washing parameters and fashion looks. Then we used the testing method to determine Tear strength and Tensile strength properties and evaluate the strength of denim goods.

## 2.3. Treatment Procedure

We followed the washing process and the recipe for the 15 gm of the sample, including the following washing process. **Table 1** shows the washing treatment, treatment condition, and the duration condition for Denim fabric:

## 2.4. Testing Procedure

### Tear Strength Test

Test method EN ISO 13937-2:2000 Tear properties of fabrics-part-2. Firstly, denim fabric was taken. Warp and weft direction of the fabric in both directions having the dimension of  $100 \times 63$  mm. The sample was fixed in the jaws of the tearing tester. A cut of 20 mm was made along the width of the fabric using the cutter in the tearing tester [18] [19]. By using the falling pendulum of the tearing tester, the fabric was a tear and the readings were noted from Elmendorf's testers scale. The same procedure was done for the different samples and the result was taken.

### Tensile strength Test

Tensile strength of the samples evaluated by tensile testing machine according to ISO 13934-2 standard. Warp and weft direction of the fabric in both directions having the dimension of  $200 \times 100$  mm. A sampled material between two attachments called "grips" which clamp up the material is the basic concept in the tensile test. The substance has known proportions, such as length and cross-section. We then start applying weight to the material that is gripped on one hand and the other.

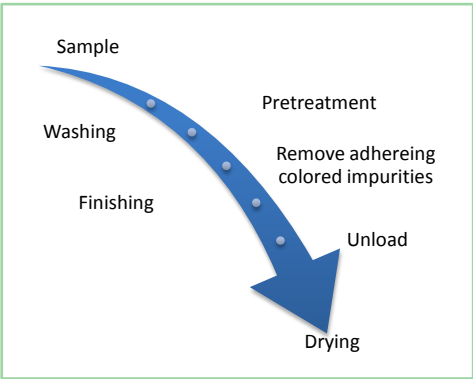
## 3. Results and Discussion

### 3.1. Different Washing Sample

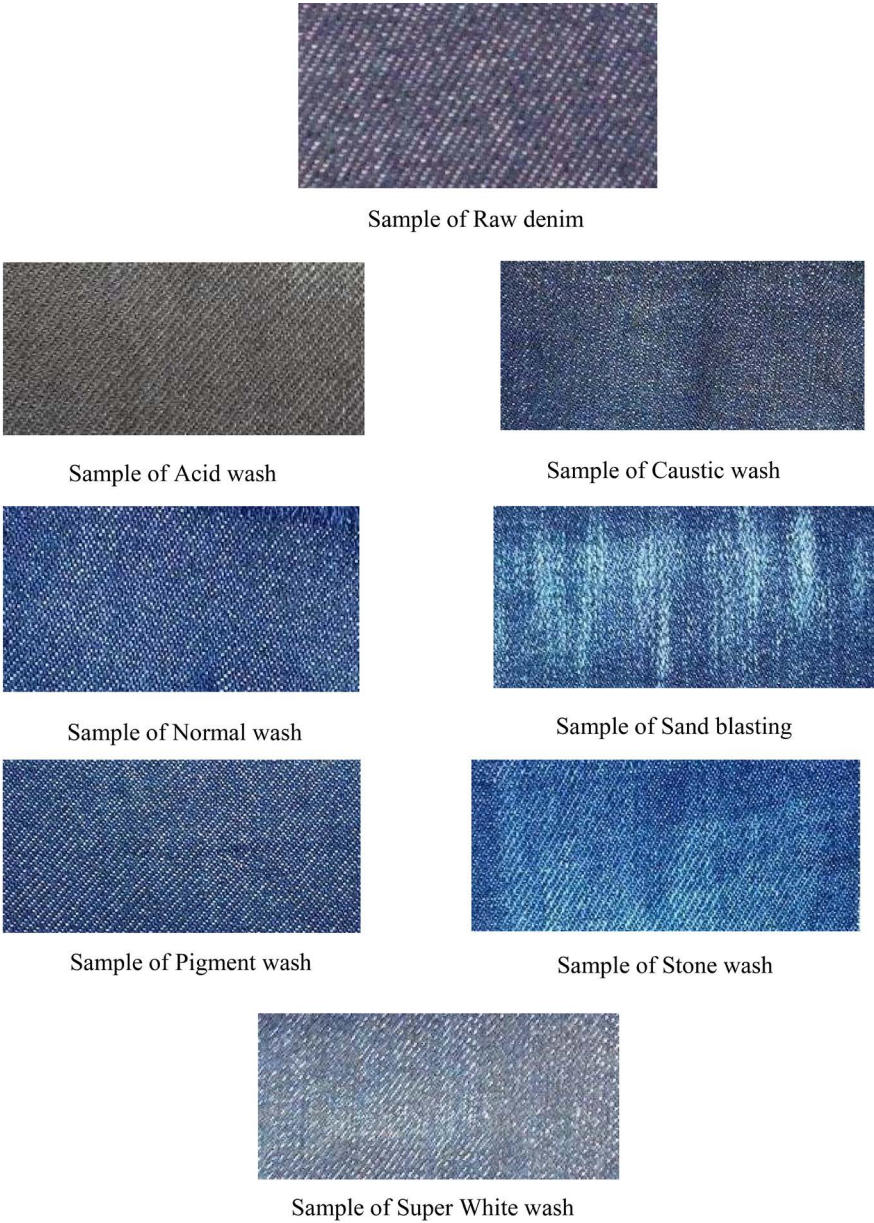
After washing, we produced different washing sample. The produced washing samples are shown in **Figure 2**.

### 3.2. Tear Strength Test Result

The Tear Strength Test is done after various washing effects on fabrics **Table 2**. Elmendorf's method is used in the test and this test is applied to the denim fabrics.



**Figure 1.** Schematic illustration of washing process.



**Figure 2.** Different washing sample.

**Table 1.** Washing treatment procedure.

Treatment	Condition	Time
Stone Wash	Temperature = 40°C	
	Total liquor	- 500 liter
	Bleaching powder	- 4% (4 kg)
	Soda Ash	- 8 kg (8%)
	Add pumic stone	- Sample (1:2)
Caustic Wash	Temperature = 60°C	
	Total liquor	- 500 litters
	Acetic acid	- 1% (1 liter)
	Softener	- 0.1% to 0.5%
Pigment Wash	Pretreatment:	
	Sample	- 100 kg
	Water	- 500 liter
	M: L	- 1:5
	Detergent	- 1% owf
	Temperature	- 60°C
	Finishing:	
Acid Wash	Softener	- 0.1% to 0.5%
	Temperature = 50°C	
	Water	- 100 L
	Potassium permanganate	- 1.2 kg
	OBA	- 500 gm (0.5%)
Sand Blasting	Total liquor	- 500 liter
	Costic soda	- 2% (2 kg)
	Hydrogen peroxide	- 5 ml/l
	Soda ash	- 2%
	Temp	- 700°C
Normal wash	Temperature = 40°C	
	Water	- 500 L
	Softener	- 0.1% - 0.5%
	Detergent	- 1 kg (1%) (Liquor)
	Color fixing agent	- 1% (1 kg)
Super White Wash	Water	- 500 liter
	Detergent	- 2%
	Caustic soda	- 4%
	Hydrogen peroxide	- 10%
	Stabilizer	- 5%
	Acetic acid	- 1%
	Florescent whiting agent (OBA)	- 1%

**Table 2.** Test results of tear strength.

SL	Composition	Cons.	Types of wash	Raw denim strength (N)		Strength after wash (N)		Raw denim strength (gf)		Strength after wash (gf)	
				warp	weft	warp	weft	warp	weft	warp	weft
01.	100% cotton	3/1 twill	Stone wash	15.01	12.00	13.75	10.99	1530.59	1223.65	1402.11	1120.66
02.	100% cotton	3/1 twill	Caustic wash	11.77	9.73	12.66	10.33	1200.21	992.18	1290.97	1053.36
03.	100% cotton	3/1 twill	Acid wash	15.01	12.00	10.75	8.73	1230.59	1223.65	1096.19	890.21
04.	100% cotton	3/1 twill	Normal wash	16.00	9.86	11.80	8.97	1631.00	1006.00	1203.00	1631.00
05.	100% cotton	3/1 twill	Pigment wash	15.01	12.00	14.05	9.10	1530.59	1223.65	1431.83	927.94
06.	100% cotton	3/1 twill	Sand blasting	13.19	11.64	12.13	10.35	1345.15	1186.94	1236.41	1055.41
07.	100% cotton	3/1 twill	Super white wash	13.19	11.64	12.12	10.25	1345.15	1186.94	1235.89	1045.21

The results are shown in the above table it is found that treatment of denim with different wash by stone and chemicals may cause a different effect. As the protruding and loose fibers are being removed by detergents.

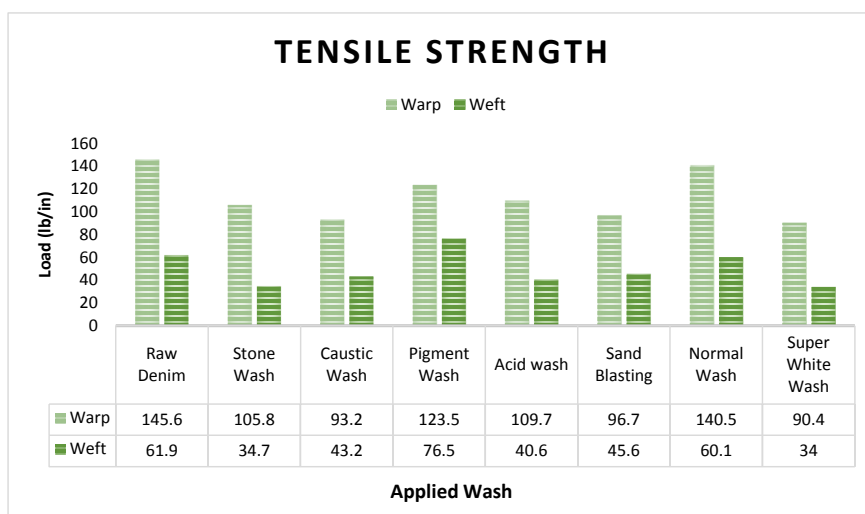
We also found that the tear strength of the denim goods after different types of washing was changed from the raw denim. Tear strength was reduced significantly after washing with different recipes both warp and weft direction. In some cases, a high reduction of tear strength in warp direction was observed in the sample. This is due to the combined action of liquid and powder detergent. Which causes more aggressive corrosion on the surface of the fabric. In caustic washing process the strength is higher compare to raw denim. This is due to the tendency of crystalline properties increase of the cellulose.

The weft tear strength of the denim sample was observed that reduction of weft wise tear strength is lower than warp wise tear strength. This is maybe due to the construction of the sample since the sample was 3 ends up warp face twill weave. As a result, warp yarns face the highest amount of friction than weft yarns. Weft yarn faces very high fluctuation in the reduction of tear strength which may be the reason for the construction pattern of the sample. The single weft yarn is down to the three-warp yarn hence the contact of detergent and stone with the weft yarn may be varied.

### 3.3. Tensile Strength Test Result

The Tensile Strength Test is done after various washing effects on fabrics **Figure 3**. ISO 13934-2 method is used in the test and this test is applied to the denim fabrics.

All the washes influence adversely on the samples. **Figure 3** represents that; tensile strength falls after washing in both warp and weft wise direction. The Super white wash sample shows the lowest result. On the other hand, the tensile strength of the Normal washed sample is much better than other samples.



**Figure 3.** Test results of tensile strength.



## 4. Conclusion

During washing, the starch surface fibers, and a few of the coloring material was removed by the abrading or predicament. The tear and tensile strength of those samples became weaker in each material direction. The loss within the sturdiness relied on the time interval because the length of the time interval, the lower the sturdiness. In line with the analysis knowledge, it may see the tear and tensile strength of the various wash are weaker. This was because of the chemical degradation of cotton and cotton fiber by the oxidizer, and therefore the abrasion action of the pumice. Compare with the various washing, a number of the material has suddenly become increase and a few are unit decreases. in line with the investigation, once the stonewash and bleaching processes area unit properly controlled, the sturdiness is maintained at an appropriate level, within the study, the result of the various levels of the factors like the various temperatures, liquor ratios, treatment times, and amount of mechanical agitation will be used for any study.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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