

Effect of Different Crushed Stone on Denim & Knit Fabric to Ensure Sustainability

Eanamul Haque Nizam*, Shihab Uddin, Moniruzzaman, Arif Reyad Sarker

Department of Textile Engineering, Southeast University, Dhaka, Bangladesh

Email address:

eanamul.nizam@seu.edu.bd (Eanamul Haque Nizam)

*Corresponding author

To cite this article:

Eanamul Haque Nizam, Shihab Uddin, Moniruzzaman, Arif Reyad Sarker. Effect of Different Crushed Stone on Denim & Knit Fabric to Ensure Sustainability. *American Journal of Science, Engineering and Technology*. Vol. 8, No. 2, 2023, pp. 97-103.

doi: 10.11648/j.ajset.20230802.13

Received: March 25, 2023; Accepted: April 14, 2023; Published: April 27, 2023

Abstract: A type of construction aggregate known as crushed stone or angular rock is typically created by mining a suitable rock deposit and then using crushers to reduce the removed rock to the required size. To comply with future sustainability, this study aims to reuse crushed stone in a factory that washes clothing. The research team therefore used crushed stone from Bangladesh (gathered from a washing factory). Crushed stone is recognized globally in 13 (Thirteen) grades. The research team chose purposes 2, 3, and 5 for the final test due to the availability and capacity limitations of washing machine facilities in factories. The variation between the fabric compositions after and before washing was addressed in this study using 06 (six) different types of denim fabric. The results of a test for color fastness to washing, rubbing, perspiration, and a shade variation were conducted after the sample denim fabrics had been cleaned. An ISO standard is followed for every washing machine test. For industrial use, the results were adequate. The research team has, at the end, provided buyers, factory owners, and future crushed stone businessmen with some recommendations that will guarantee sustainability in factories.

Keywords: Crushed Stone, Garments Washing, Denim, Sustainability

1. Introduction

A recently produced piece of cloth can be given a worn-in (or worn-out) appearance by using the textile manufacturing process of stone washing. The stone's hardness, shape, and size must be appropriate to produce the desired stone washing effect for the denim clothing. It is common knowledge that the softening and color fading effects of washing denim garments depend greatly on the use of chemicals and stones [1, 2]. For denim or canvas, it is a well-liked wash. Materials with even, high strength, and robust properties are required for fabric finishing techniques like stone washing, damaged looks, and so forth. Additionally, stonewashed or sand washed fabrics with a worn-in or even faded appearance are becoming more popular in denim fashion trends. The denim market, which accounts for about 3% of the entire textile market, has been steadily expanding over the past few years [3, 10].

Construction aggregate, such as crushed stone or angular rock, is typically created by mining a suitable rock deposit and using crushers to reduce the removed rock to the required size.

It differs from naturally occurring gravel, which is created by erosive weathering processes and typically has a more rounded shape. The main component of macadam road construction, angular crushed stone, depends on the interlocking of the angular faces of the individual stones for strength [4].

- 1) As riprap
- 2) As railroad track ballast
- 3) As filter stone.
- 4) As composite material (with a binder) in concrete, tarmac, and asphalt concrete.

1.1. Crushed Stone Grade 1-10 [5, 6, 13]

Generally, as the grade number goes up, the size of the stone goes down.

1 - Crushed stone in the 1 crushed stone grade, which is the largest of the crushed stone grades, ranges in length from 2-4

inches. For bigger jobs or to fill in bigger holes, this material works great.

3 - The length of the stone in this size ranges from 1/2 to 2 inches. For projects requiring drainage and railroads, this material is a great option.

The size of crushed stone in the number 5 is one inch or less. For use as a paver base and road surface, this material is ideal.

8 - The size of these stones ranges from 3/8 to 1/2 inch. It is the stone that is used in concrete mixtures the most frequently.

10 - Crushed stone 10 is also referred to as dust or screenings. Pavers and concrete blocks are typically made

with this material.

1.2. Objective of This Study

- 1) To know about Stone & Stone washing process.
- 2) To know about Crushed Stone & Crushed stone grades.
- 3) To create wash effect of fabrics or garments by using crushed stone.
- 4) To decrease stone cost and ensure sustainability.
- 5) To achieve buyer wash standard by using crushed stone.

2. Material & Method

2.1 Materials

Table 1. FABRICS (DENIM).

SL NO	FABRIC COMPOSITION	FABRIC CONSTRUCTION	GSM in OZ
01	66% Cotton 25% Poly 8% Rayon 1% Spandex	91 x 48/10 x 16+40D	10.5
02	70% Cotton 28% Poly 2% Spandex	10 x 300/70D	11.0
03	71.5% Cotton 25% Tensile 2% Rayon 1.5% Spandex	RS 10 x T/R16/70D 94 x 53	10.5
04	77.5% Cotton 21.2% Poly 0.3% Rayon 1% Spandex	10 x 150 / 40D	8.5
05	70% Cotton 29% Poly 1% Spandex	16 x 200 / 40D	8.5
06	80% Cotton 18% Polyester 2% Spandex	15 x 200 / 70D	9.0

Table 2. FABRICS (KNIT).

SL NO	FABRIC COMPOSITION	FABRIC CONSTRUCTION	GSM in gm/m ²
01	97% Cotton 3% Elastane	30 x 24 30 ^s + 40D	240
02	100% Cotton	28 x 20 16 ^s / 1	230
03	95% Cotton 5% Elastane	30 x 24 26 ^s + 70D	320
04	82% Cotton 14% Polyester 4% Elastane	30 x 20 30 ^s / 1 + 40D +75D	200

Table 3. CHEMICALS [14, 15].

SL NO	NAME	BRAND	REMARKS
01	Queenpers M-40		Antiback-Stain
02	Lava Cell NLG New		Enzyme (Powder)
03	Lava Cell NSY		Enzyme (Powder)
04	Royazyme SC 750 CONS		Enzyme (Powder)

Table 4. MACHINES.

SL NO	NAME	BRAND	REMARKS
01	WASHING MACHINE	DANIS-DCN 028, DCN110	
02	WASHING MACHINE	TONELLO-HW, 70LW1	
03	DRYER MACHINE	TRIVENETA-GRANDI IMPIANTI	
04	HYDRO EXTRACTOR		
05	ROZA COLOR FASTNESS	SDL ATLAS	
06	CROCK METER	SDL ATLAS	
07	INCUBATOR	PERSPIROMETER KIT SDL ATLAS	
08	SPECTOPHOTO METER	SPECTRUM	
09	LIGHT FASTNESS MACHINE	ATLAS/AMET EK	

2.2. Methodological Framework

Figure 1 shows the overall layout of this study. Different kinds of denim fabric have been gathered from Bangladeshi local markets and factories since the study's inception.

Following that, the crushed stone was gathered from a Bangladeshi factory close by. After following the instructions, various tests of the crushed stone wash have been carried out in the factory to meet buyer standards.

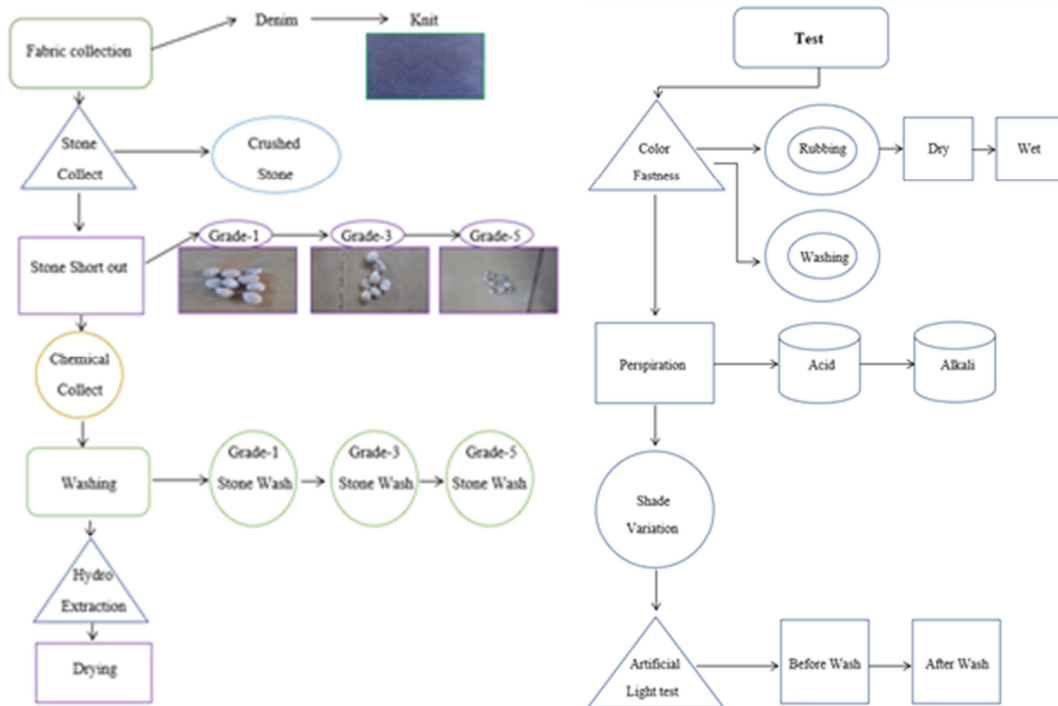


Figure 1. A glimpse of methodological framework of this study.

3. Results & Discussions

3.1. Color Fastness to Rubbing

Table 5. COLOR FASTNESS TO RUBBING (DENIM)- ISO 105 X 12.

SAMPLE NO	1 ST WASH		2 ND WASH		3 RD WASH	
	DRY	WET	DRY	WET	DRY	WET
01	4-5	1	4-5	1	2-3	1
02	4-5	1	4-5	1-2	4	1
03	4-5	1	4-5	1	4-5	1
04	4-5	1	4-5	1	4-5	1
05	4-5	3	4-5	3	4-5	2-3
06	4-5	1	4-5	1	4	1-2

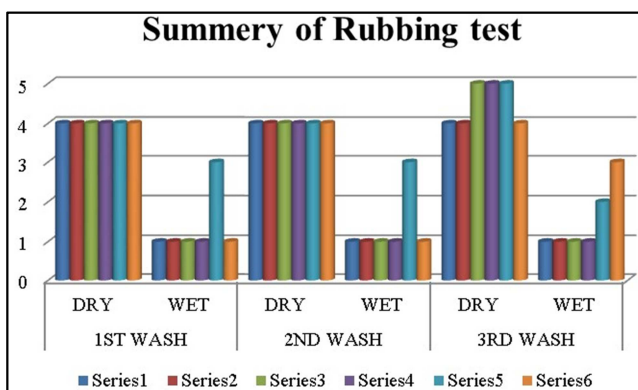


Figure 2. Summary of Rubbing test.

Discussion: Table 4 and Figure 2 show that the dry rubbing test result for the first wash is 4-5, which is excellent, but the wet rubbing test result for a few samples is 1 and 3 for one sample. The results of the second wash's dry rubbing are 4-5

and the wet results are 1-3. For the third wash, dry rubbing is also beneficial because 4-5 means the color wasn't stained while wet is 1-3. Wet rubbing test results were 1-3 because we only needed to use a tiny amount of chemical and crushed stone because we only needed to wash a few tiny pieces of fabric for the test. Wet rubbing results are less due to the necessity of reducing washing time and temperature.

3.2. Color Fastness to Rubbing

Table 6. COLOR FASTNESS TO RUBBING (KNIT) – ISO 105 X 12.

SAMPLE NO	1 ST WASH		2 ND WASH		3 RD WASH	
	DRY	WET	DRY	WET	DRY	WET
01	4-5	2	4-5	2	4-5	2
02	4-5	2-3	4-5	2	4-5	2-3
03	4-5	3-4	4-5	3-4	4-5	3-4
04	4-5	3-4	4-5	2	4-5	2

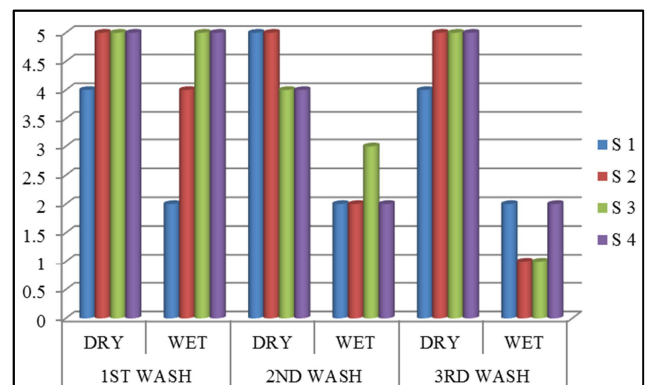


Figure 3. Color Fastness to Rubbing (Knit).

Discussion: As shown in table 5 and Figure 3, the average

dry rubbing result after the first, second, and third washes is 4-5. When compared to the scale, it indicates that this sample did not cause the color to bleed, indicating a positive outcome.

3.3. Color Fastness to Washing

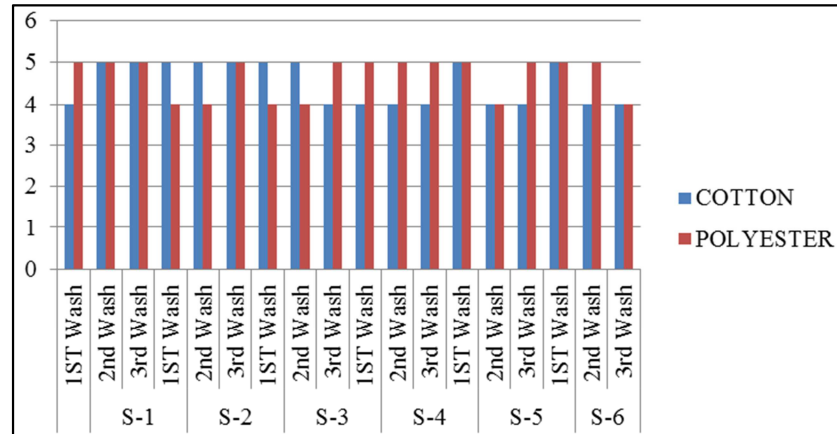


Figure 4. Summary of Color Fastness to Washing (Denim).

Table 7. COLOR FASTNESS TO WASHING (DENIM) – ISO 105 C06.

		COTTON	POLYESTER
SAMPLE-01	1 ST Wash	4-5	4-5
	2 nd Wash	4-5	4-5
	3 rd Wash	4-5	4-5
SAMPLE-02	1 ST Wash	4-5	4-5
	2 nd Wash	4-5	4-5
	3 rd Wash	4-5	4-5
SAMPLE-03	1 ST Wash	2-3	4-5
	2 nd Wash	2-3	4-5
	3 rd Wash	2-3	4-5
SAMPLE-04	1 ST Wash	4	4-5
	2 nd Wash	4	4-5
	3 rd Wash	4	4-5
SAMPLE-05	1 ST Wash	4-5	4-5
	2 nd Wash	4	4-5
	3 rd Wash	4	4-5
SAMPLE-06	1 ST Wash	4-5	4-5
	2 nd Wash	4	4-5
	3 rd Wash	4	4-5

For the first, second, and third washes after dry rubbing, we receive an average result of 2-4. This result indicates fairness and acceptability by comparing with a scale.

washing every sample, we checked the results using a greyscale, and they matched the actual results because there was little to no color bleed.

3.4. Color Fastness to Washing

Table 8. COLOR FASTNESS TO WASHING (KNIT) – ISO 105 C06.

		COTTON	POLYESTER
SAMPLE-01	1 ST Wash	4-5	4-5
	2 nd Wash	4-5	4-5
	3 rd Wash	4-5	4-5
SAMPLE-02	1 ST Wash	4-5	4-5
	2 nd Wash	3-4	4-5
	3 rd Wash	3-4	4-5
SAMPLE-03	1 ST Wash	4-5	4-5
	2 nd Wash	4-5	4-5
	3 rd Wash	4	4-5
SAMPLE-04	1 ST Wash	4-5	4-5
	2 nd Wash	4-5	4-5
	3 rd Wash	4	4-5

Discussion: According to table 6 and Figure 4, all three washed denim fabrics score 4-5 for color fastness to washing with cotton and polyester. This is a typical outcome. After

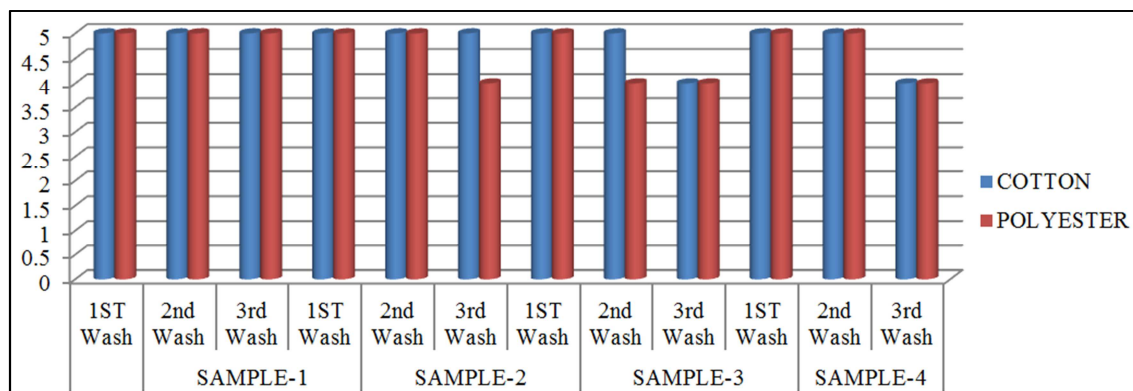


Figure 5. Summary of Color Fastness to Washing (Knit).

Discussion: Table 8 and Figure 5 show that all 3 washed knit fabrics score 4-5 for color fastness to washing for cotton and polyester, which is a typical outcome. We checked the

results using a greyscale after washing all the samples, and they matched this outcome because there was little to no color bleed.

3.5. Color Fastness to Perspiration

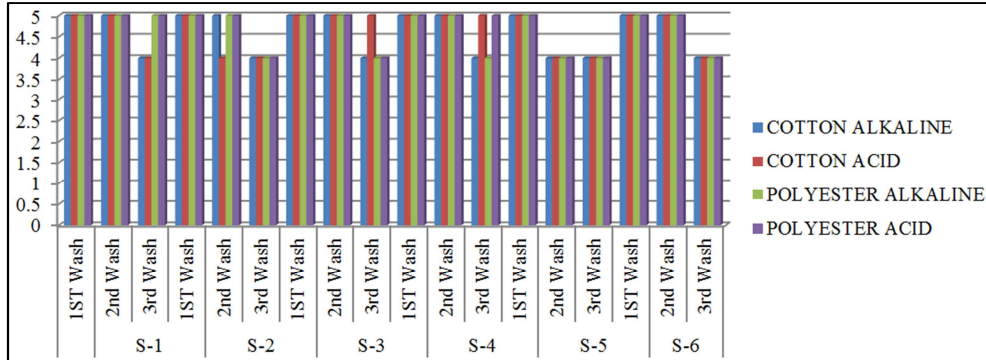


Figure 6. Summary of Perspiration test (Denim).

Table 9. PERSPIRATION (ACID & ALKALI) TEST- (DENIM) ISO 105 E04.

		Cotton		Polyester	
		Alkaline	Acid	Alkaline	Acid
SAMPLE-01	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5
SAMPLE-02	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5
SAMPLE-03	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5
SAMPLE-04	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5
SAMPLE-05	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5
SAMPLE-06	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5

From table 9 and Figure 6 we can see that the result of perspiration (Acid & Alkali) is 4-5. Grey scale says that 4-5 means that sample didn't change the color.

3.6. Color Fastness to Perspiration

Table 10. PERSPIRATION (ACID & ALKALI) TEST- (KNIT) ISO 105 E04.

		Cotton		Polyester	
		Alkaline	Acid	Alkaline	Acid
SAMPLE-01	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5
SAMPLE-02	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5
SAMPLE-03	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5
SAMPLE-04	1 ST Wash	4-5	4-5	4-5	4-5
	2 nd Wash	4-5	4-5	4-5	4-5
	3 rd Wash	4-5	4-5	4-5	4-5

Discussion: We know that the standard result for Perspiration (Acid & Alkali) test of cotton and polyester is 4-5.

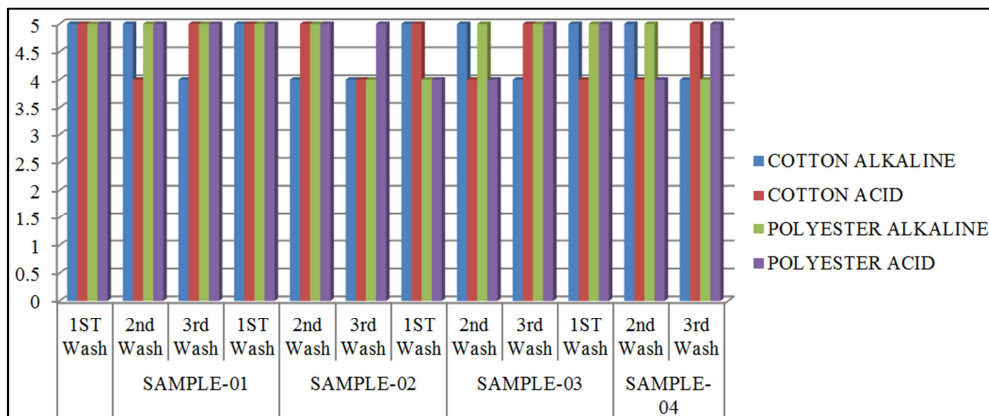


Figure 7. Summary of Perspiration test (Knit).

Discussion: We know that the standard result for Perspiration (Acid & Alkali) test of cotton and polyester is 4-5. From table 10 and Figure 7 we can see that the result of perspiration (Acid & Alkali) is 4-5. Grey scale says that 4-5 means that sample didn't change the color.

4. Conclusions

This crushed stone wash work was extremely novel and difficult. We worked as hard as we could to finish this project quickly. With three different grades [7-9], we are working. As a result of what we've learned, this is a feasible wash that has the potential to be long-lasting. If anyone wants to go further with their work with crushed stone wash, they should work with different grades of the material, try working with a lot of different fabrics, and try to implement in large quantities [11, 12].

5. Recommendations

FOR BUYER

Stone wash is always advised by buyers to produce a nice wash effect on fabrics or clothing. We are aware of two categories of stone: 1. Two things: natural stone. The pumice stone. We look for evidence that natural stone was too expensive for our factories to purchase any. The stone they purchase is either artificial stone or pumice stone. Pumice stone must be procured from foreign nations, such as Turkmenistan, which drives up the cost of the stone. Crushed stone and new stone were recently combined for use in some factories. But in doing so, they must first purchase new stone. To use this crushed stone in a challenging way, we shorten different grades and create a buyer-standard wash effect. Crushed stone is rarely able to produce a wash effect. Therefore, we urge our customers to put the wash effect first when defining stone size rather than the wash standard. It can improve our sustainability while lowering the cost of the stone.

FOR FACTORY OWNER

Don't throw away stone after using it. To lower the cost of washing stone, please haggle with customers who want to order stone washing services. Because using Moriball instead of crushed stone will be very expensive. We attempt to shorten crushed stone to a different grade to use it to produce the buyer's standard wash effect. To reduce the cost of stone wash and contribute to sustainability, we therefore urge factory owners to use this method. Because before placing an order, every customer wants to confirm the sustainability of the wash recipe. They didn't place the order if they don't find any sustainability. So, you can use this technique to offer the buyer a sustainable wash.

FOR THE STONE BUSINESSMAN

Crushed stone can be shorted out into a variety of grades, and because of some restrictions, we used 4-5 grades to produce a nice wash effect. We found this method to be practical and sustainable. There will be a great opportunity to launch a crushed stone business if factory owners collect that crushed stone in some grade-wise fashion, start using it, and

customers recommend using it as a sustainable solution. Thus, there is no need to discard any crushed stone. That stone is available for very cheap sale. In this field, we're attempting to develop some new entrepreneurs.

Acknowledgements

The research team has given their special gratitude to Koronni group of industries for giving us the permission to conduct all the test and trial the fabric in their washing machine.

References

- [1] Engr. Md. Eanamul Haque Nizam, Khalid Hassan, Jabelul Islam, Shajib Islam, Md. Ibrahim Khan, Md. Ashikuzzaman, Impact of Garments Washing Defects on the Economy of Bangladesh, *International Journal of Textile Science*, Vol. 11 No. 1, 2022, pp. 12-18. doi: 10.5923/j.textile.20221101.03.
- [2] Jahan, T. and Khan, J. (2022) Impact of Stone Enzyme Wash and Acid Wash Based on Denim Garments. *Journal of Textile Science and Technology*, 8, 43-57. doi: 10.4236/jtst.2022.81005.
- [3] Siddiquee, M., Moula, A., Saha, J., Kabir Khan, M., Kaisar, Z. and Roy, A. (2022) Sustainable Denim Washing by Process Optimization. *Journal of Textile Science and Technology*, 8, 149-162. doi: 10.4236/jtst.2022.84012.
- [4] Shamim, S., Khan, M., Hossan, S. and Uddin, M. (2020) Study on Comparison between Enzyme Wash and Bleach Wash (Traditional vs. Sustainable Washing Machine) the Physical and Color Fastness to Rubbing Properties of Denim Garments. *Journal of Textile Science and Technology*, 6, 123-129. doi: 10.4236/jtst.2020.63010.
- [5] Solaiman, Rouf, A., Rasel, S. and Khalil, E. (2015) Investigation of Different Washing Effects on Physical and Mechanical Properties of Cotton Knitted Garments. *Journal of Textile Science and Technology*, 1, 101-109. doi: 10.4236/jtst.2015.13011.
- [6] Hasan, M., Asif, A., Razzaque, A., Hasan, M., Sur, S. and Faruque, M. (2021) An Experimental Investigation of Different Washing Processes on Various Properties of Stretch Denim Fabric. *Journal of Materials Science and Chemical Engineering*, 9, 1-15. doi: 10.4236/msce.2021.91001.
- [7] Ahamed, J., Mahmud, M., Ahammed, M., Mia, R., Hasan, M., Khan, T., Limon, G. and Shamim, A. (2021) Evaluate the Strength of Denim Goods Using Different Washing Technique. *Journal of Materials Science and Chemical Engineering*, 9, 1-8. doi: 10.4236/msce.2021.93001.
- [8] Kashem, M. A. (2008). *Garments Merchandising* (1st ed.), (Pp. 69-71), Dhaka: Lucky-One Traders.
- [9] Azam, M. S., Saleh, M. S., & Nafiz, K. A. (2009). *An Introductory Knowledge about Garments Manufacturing Technology* (1st ed.), (Pp. 281-282), Dhaka: Books Fair Publication.
- [10] Rahman, M. S. (2013). *Practical Handbook of Washing & Dyeing* (2nd ed.), (Pp. 101-104), Dhaka, S. A. Corporation.
- [11] Pal, S. *Technology of Denim Production: Part VI*. Retrieved from <http://www.fibre2fashion.com/>.

- [12] Unique Washing (2013), personal communication, Unique Washing, and Dyeing Ltd., Kalameshar, Gazipur, Dhaka, Bangladesh.
- [13] Haq, U. N., and Khan, M. M. R. (2014) Technology of Acid Wash on Woven Denim Apparel with Damp Pumice Stone.
- [14] WEN-BIN, Z. 2008. Common denim washing tech-ologies [J]. Dyeing & Finishing, 7.
- [15] RASEL, M. S., DAS, D. & KHAN, M. R. Current Scenario of Textile Sector in Bangladesh (2019); A Comprehensive Review.