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EFFECTS OF GARMENT LAUNDRY ACTIVITIES ON THE SLIDER LOCK AND CROSSWISE STRENGTHS OF NYLON COIL ZIPPERS

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ABSTRACT
Zippers are textile fastening devices which are flexible and operate by moving a slider along two rows of inter-lockable elements. In Nigeria, the polyester and nylon coil type of zippers are the most commonly used and patronized by makers of female garments and dresses. Previous study on the strength of zippers in a region similar to Nigeria showed zipper failures were as a result of wrong application of zipper to garment fits. In this study, the effect of laundering activity on the crosswise strength and slider lock strength of the nylon coil zipper in Nigeria was investigated. Two (2) sets of #3 nylon coil zippers were separated into groups and subjected to a number of wash cycles. The crosswise strength and slider lock strength tests were performed and the results were compared to a group of control-samples. The average slider lock strength for the Gyro Washed samples were 54.28 N, 43.31 N and 44.27 N for the first, second and third Wash cycles respectively; while the control samples recorded an average strength of 47.28 N. The average crosswise strength recorded were 679 N, 667 N and 680 N for the first ,second and third Wash cycles respectively; while the control samples recorded an average strength of 486.04 N. The Average slider Lock strength recorded from the Motorised Tensometer for the hand washed samples were 45.0 N, 50.0 N and 48.3 N for the for the first ,second and third Wash cycles respectively, while the control samples recorded an average strength of 33.3 N. The results showed that laundry/wash activity has an effect on the slider lock and cross wise strength of the zippers which can also hinder the smooth operation/movement of sliders along the zipper elements/chain.

Keywords: *crosswise strength, slider lock strength, zippers*

1. INTRODUCTION

A zipper is a device consisting of two rows of metal or plastic teeth like parts that are brought together by pulling a small sliding piece over them. They are commonly used for fastening or temporarily joining two separated ends or pieces of a fabric, cloth or textile material together. According to Gaddis (2011), zippers are arguably "the first machines that people learnt to master in their childhood and have remained the most common mechanism of daily lives". Zippers require precision and are more technical and mechanical in their application compared to buttons and pins which are also commonly used in the fashion and textile industry.

As a flexible joint device and like any other mechanical joint, zippers are expected to exhibit strength and resistance to forces they will be subjected to during use. Gaddis (2011) explained that there are various methods for evaluating zipper strength using a tensile testing machine. Some of these are by examining crosswise stop strength, vertical tensile strength, strength of the top stop, slider lock strength, overall strength of the box and the zipper fabric tearing strength (BS 3084: 2006).

In the Nigerian market there are different types of zippers available, some of which are the one way zippers, two way zippers, polyester zippers, plastic zippers and metal zippers amongst many others. A visit to some tailor shops revealed that the preferred type of zipper usually depends on the expertise of the dressmaker, the type and colour of garment being made, the price and the size of the zipper. It also revealed that most dressmakers in Nigeria use the one way coil zippers in zipper application to female garments made from textile materials called African prints and popularly known as "Ankara".

Modern Laundry is done with the use of various types of washing machines. The most common and popular laundry activity practised in Nigeria is by "Hand Wash". It is also done with the use of any easily available and affordable soap or powder detergent. Local laundry service men also wash clothes in this manner and are patronized mostly by the lower and middle classes of the Nigerian society. Laundry activity is primarily intended to remove dirt and stains from fabric and a zipper will have to be subjected to the same conditions as the garment to which it is attached.
This research work looks into the effect of garment laundry activity on zipper strength.

A zipper is a fastening device consisting or parallel rows of metal, plastic or nylon teeth on adjacent edges of an opening that are interlocked by a sliding tab (Frings, 2002). These teeth can be either individual or shaped from a continuous coil and are also referred to as elements (YKK, 2011).

The sliding tab which is also referred to as a slider is operated by hand to move along the rows of teeth. Inside the slider is a Y-shaped channel that meshes or separates the opposing rows of teeth depending on the direction of the slider movement (ASTM D2050 – 11).

According to Jyler (2008), zippers are the principal items used in clothing that are partly textile in nature and partly non-textile, hard material. They provide a neat strong fastening in garments, and can be functional or decorative or both.

Zippers may be used to:

i. Increase or decrease the size of an opening to allow or restrict passage of objects as in the fly (i.e. opening) of trousers or in a pocket.
ii. Join or separate two ends or sides of a single garment, as in the front of a jacket, or on the front, back or side of a dress or shirt to facilitate dressing.
iii. Attach or detach a separable part of a garment to form another, as in the conversion between trousers and shorts or the connection or disconnection between a hood and coat.
iv. To decorate an item.

Zippers are applied to other textile products such as bags, luggage and foot wear; they also help to make life easier for people with disabilities because of the ease with which they can be operated.

No one element of a garment can cause as much grief for a product developer as a zipper that fails. Zippers, despite their importance and worry-free use, are complicated devices that rely on a smooth, almost perfect linkage of tiny cupped teeth (Keiser and Garner, 2012).

The problems that often lie with zippers are related to the zipper slider when it became worn and weak and does not properly align and join the alternating teeth/element (Nkrumah, 2014). If a zipper fails it can either get stuck, partially break off (Nkrumah and Pardie, 2011) or ply open anywhere along the interlocked element (chain).
The aim of this study is to examine the effect of laundry practice on the strength of Nylon coil zippers in Nigeria.

2.0 MATERIALS AND METHODS

2.1 Materials

The following materials were used for Test:

i. Zipper samples
ii. OMO fast-action (powder) detergent
iii. ISO standard soap (powder) (British Standard)
iv. Anhydrous sodium carbonate (powder)
v. Distilled water

The zipper samples chosen for this test was the #3 Nylon coil zipper with the brand name 'Two Rose'. They were obtained from a local distributor in a market at Kaduna, Kaduna state, Nigeria. The length and width of each sample was measured to be 203.2 mm and 2.6 mm respectively.

2.1.1 Apparatus/Equipment Used

The Equipment used for this test are as follows

i. 250 cm^3 measuring cylinder
ii. 25 ml beaker
iii. Metal cans and stainless steel bowls
iv. SON approved testometric materials testing machine
v. SON approved gyro washing machine
vi. SON approved weighing scale
vii. Motorized automatic recording tensometer

2.2 Methodology

Sixteen (16) zipper samples with an average weight of 3.19 grams were divided into 4 groups [4 zippers per group];3 groups were subjected to a standard wash process in a SON approved Gyro Machine Washing and another group to Hand washing.

2.2.1 Gyro Wash Machine

The washing composition was prepared in the textile and leather laboratory of the Standard Organization of Nigeria, Kaduna branch. 5 g of ISO standard soap powder was measured and mixed with 2 g of anhydrous sodium carbonate powder in a 250 ml beaker. Distilled water was added to make a 250 ml solution which was then transferred into a 1000 ml flat bottom volumetric flask. The flask was carefully filled with distilled water till the washing solution reached the 1000 ml mark.
For each group of samples placed in the Gyro metal cans, 160 ml of the soap solution was added. The metal cans were placed in the gyro washing machine and allowed to operate for 45 min at a temperature of 50 ^0C which was set on the machine.

The first group of zippers were removed and tested for their strength while the second and third groups of zippers were subjected to a second and third wash cycle respectively. After each wash cycle, a group of zippers were removed and dried; the zippers were then tested for their strengths.

Fig. 1: A group of zipper Samples

Fig. 2: Zipper samples in metal cans

Fig. 3: Gyro Washing Machine

2.2.3 Hand Washed

A set of 9 samples were subjected to hand wash using the popular OMO fast-action powder detergent. 3 groups were subjected, respectively, to a first, second and third wash cycle in stainless steel bowls. The washing liquid was composed of a mixture of 1.25 liters of water and 10 ml of OMO fast action detergent powder for each cycle.

The samples were allowed to soak for 45 mins under natural weather conditions before washing, rinsing and drying. The samples were rinsed and dried after each wash and a group of zipper samples were taken after each cycle to have their slider lock strengths tested and compared to the control samples.

2.2.4 Strength Test

A Motorized Automatic Recording Tensometer was used to test the slider lock strengths of the zippers and the force at which slider was unlocked was recorded.
The strength tests of the samples were carried out in the textile and leather laboratory of the Standard Organization of Nigeria, Kaduna office.

i. Slider lock strength

This is the test method which measures the ability of the locking mechanism of a slider to hold the slider in a locked position on the chain when stress is applied through the stringers. Using the S.O.N approved testometric materials testing machine with adherence to ASTM D2061 - 03 standard of measurement, the distance between the clamps of the testing machine was set at approximately 76.2 mm (3 inches). The slider was located midway between the ends of the chain (i.e. about 38 mm from the top stop of a closed zipper). One of the stringers emerging from the throat of the slider was secured in the upper clamp and one in the lower clamp of the testing machine. The slider body was positioned along the axis of the clamp and mid-way between them. The machine was then activated to apply load/force at a constant rate until the slider eventually slipped or till the zipper eventually breaks.

ii. Crosswise strength

This test method is used to measure the resistance of a zipper of such failure as tape rupture, un-meshing, or element separation when the zipper is side stressed. Using the S.O.N approved testometric materials machine with adherence to ASTM standard of measurement, the tapes of the zipper or chain were secured in the clamps of the tensile testing machine with the edges of the jaws parallel to the chain and approximately 3 mm (1/8 inches) from the outer edge of the inter-locking elements. The ends of the front Jaws were positioned 25 mm from the top stops. The machine was activated to apply an increasing load/force until the element either pulls off or until the tape separates or gets damaged.

For each group of zippers, 2 samples were tested for their slider lock strengths while the other 2 samples were tested for their crosswise strengths.

Figure 4 Testometric Materials Testing Machine

3.0 RESULTS AND DISCUSSION

3.1 Results

3.2 Discussion

Generally it was observed that the zippers were distorted after the strength tests; the dimensions were altered. The slider movement along the chain/element became a little bit rough and needed a little extra effort in zipping after washing the samples. (There was a decline in the smooth operability of the zipper slider after washing). Below is the specific discussion on the specific strength tests.

3.2.1 Slider Lock Strength (Testometric Materials Testing Machine)

Using the Materials Testometric Testing Machine, the Load/Force and Extension results for the slider lock strength test of the control samples were recorded as 46.44 N and 48.12N; while the results for the slider lock strength tests of the samples subjected to first, second and third wash cycles in the Gyro Washing Machine were recorded as 55.52 N and 53.64 N; 42.46 N and 41.31 N; 42.86 N and 45.68 N respectively; as shown in Figure 5 and Table 1.

Samples from the first wash required an average load/force higher than that of the control samples to unlock the slider and force it to slide down the zipper chain, while the samples from the second and third wash required a lower load/force to unlock the slider.

Also, the samples from the first wash cycle recorded the highest percentage increase in strength, differing significantly from that of the second and third groups. The effect of a higher washing temperature must have caused the decline in the average slider lock strength of the second and third groups of zipper samples.

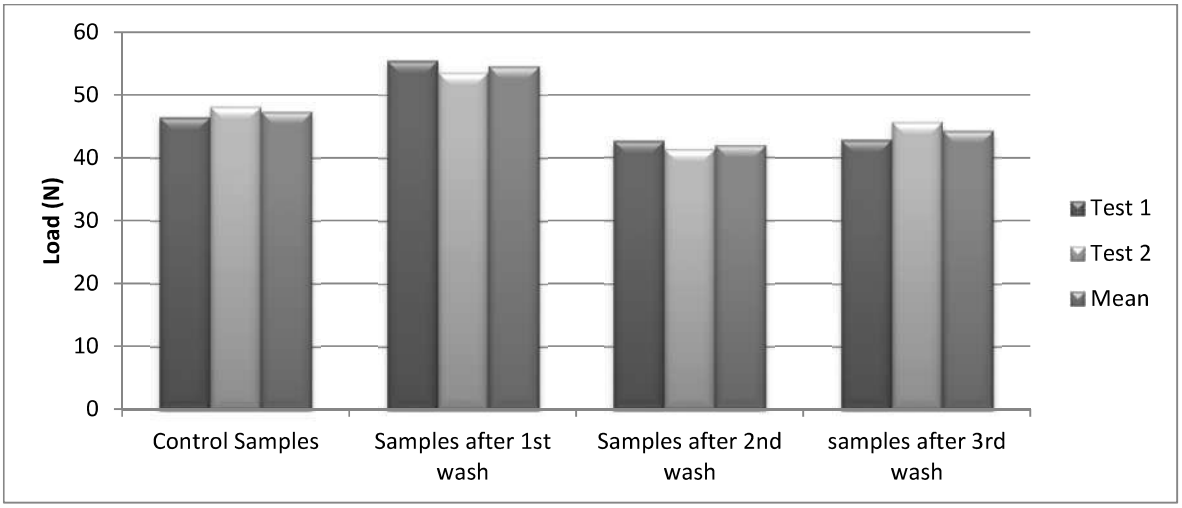

Figure 5 Effect of Gyro-Washing Process (At 50 °C) on the Slider Lock Strength of Zipper Samples

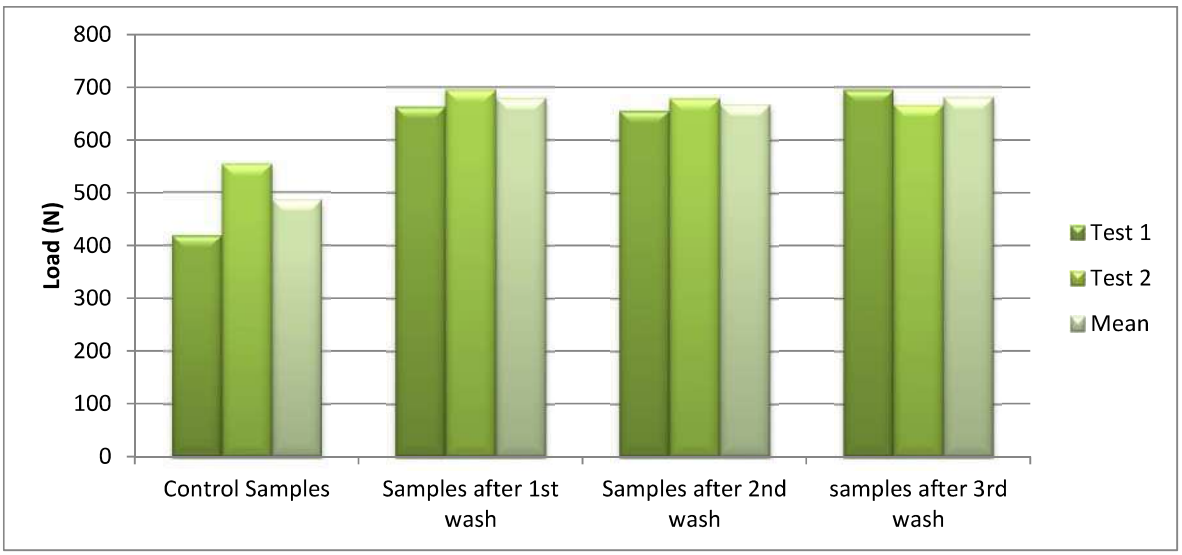

Figure 6 Effect of Gyro-Washing Process (at 50 °C) on the Cross Wise Strength of Zipper samples

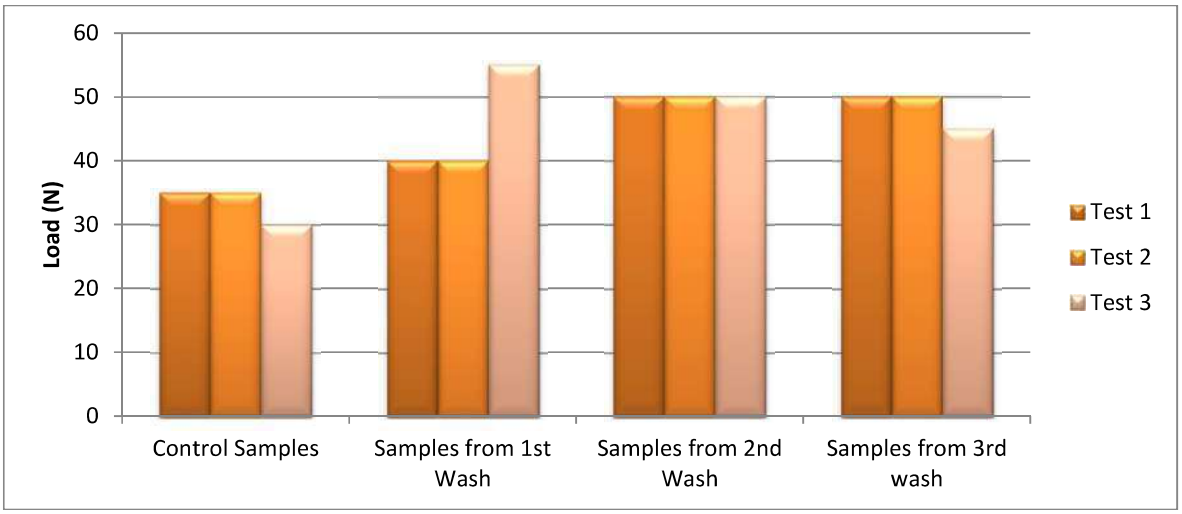

Figure 7 Effect of detergent soap/Hand-Wash on the slider lock strength of Zipper samples

Table 1 Load Difference and % Change in Slider Lock Strength of Gyro Machine Washed Samples

	Load (Newton)			
GROUP	**Average Load**	**Control Value**	**Load Difference**	**% Difference**
Group 1	54.58	47.28	7.3	15.44%
Group 2	41.975	47.28	-5.305	-11.22%
Group 3	44.27	47.28	-3.01	-6.4%

Table 2 Load Difference and % Change in Crosswise Strength of Gyro Machine Washed Samples

	Load (Newton)			
GROUP	**Average. Load**	**Control value**	**Load Difference**	**% Difference**
Group 1	679.015	486.04	192.975	39.73%
Group 2	667.8	486.04	181.76	37.4%
Group 3	680.45	486.04	194.41	39.99%

Table 3 Load Difference and % Change in Slider Lock Strength of Hand Washed Samples.

	Load (Newton)			
GROUP	**Average Load**	**Control Value**	**Load Difference**	**% Difference**
Group 1	45	33.33	11.67	35%
Group 2	50	33.33	16.67	50%
Group 3	48.33	33.33	15	45%

3.2.2 Crosswise Strength (Testometric Materials Testing Machine)

Using the Testometric Materials Testing Machine, the results for the crosswise strength test of the control samples were recorded as 418.38 N and 553.7 N; while the results of crosswise strength tests of the samples subjected to first, second and third wash cycles in the Gyro Washing Machine were recorded as 663.1 N and 694.9 N; 656.1 N and 679.5 N; 695.2 N and 665.7 N respectively as shown in Figure 6 and Table 2. It was also observed that during the tests, the zipper tapes were ruptured while the chain/interlocked elements remained intact.

In this case, Samples from the 3 groups required an average load/force higher than that of the control samples to rupture the zipper tape during the crosswise strength test. The percentage increase in average strength of the 3 groups of zipper samples were of very close range and these values did not differ significantly from one another.

3.2.3 Slider Lock Strength (Motorized Automatic Recording Tensometer)

Using the Motorized Automatic Recording Tensometer, the results for the slider lock strength test of the control samples were recorded as 35 N, 35 N and 30 N; while the results for the slider lock strength test of the samples that were subjected to first, second and third wash cycles using the hand wash method were recorded as 40 N, 40 N and 55 N; 50 N, 50 N and 50 N; 50 N, 50 N and 45 N respectively as shown in Figure 7 and Table 3. It was also observed that during the tests, there was lock slippage; the slider was unlocked with the application of force and the zipper was still operable afterward.

From the Hand wash process, samples from the first wash required a higher load/force than the control samples to unlock the slider, while the samples from second and third wash required much higher load/force to unlock the slider.

4.0 CONCLUSION

It can be concluded that the crosswise strength of the #3 nylon coil zipper, which recorded the highest strength value, was much greater than its slider lock strength.

Laundry/Washing of Fabrics/Garments with nylon coil zipper applications has an effect on the strength of zippers. It also affects the smooth operation of the zipper slider along its chains.

The slider locks strength of the Hand – wash samples from the 3 groups increased after washing. The decline in the slider lock strength of zipper samples from the second and third wash cycles of the Gyro Wash machine may be as a result of its washing temperature (i.e. 50^{o}C). However, according to the tests and results obtained, this effect of washing temperature on the cross wise strength was negligible. The percentage increase in the crosswise strength of samples from the three (3) groups showed that washing have less impact on the crosswise strength.

Based on the findings of this study, the following may be recommended:

1. Laundry activity should always consider the type of zipper applied to the garment/fabric being washed.
2. Further investigation into the effect of laundry activity on the strength of zippers used in

Nigeria should be carried out with an increased number of samples whereby the standard deviation and coefficient of variation of the control samples can be compared with that of the laundered samples.

3. The effect of laundering factors such as Temperature, Time and Laundry Agent Concentrations on the strength of zippers should be carried out.
4. The testing machine to be used for the strength test of zippers should have the proper jaw clamps and fixtures for the specific strength test method desired; this is to ensure that there is no difficulty and waste of time in securing any part of the zipper to clamps.

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