Study on the causes and remedies of ball formation in looms due to improper sizing


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Abstract

Textile industry is a significant source of revenue in Bangladesh. More effort is being put into producing high-quality woven fabrics. The generation of fiber balls is a significant challenge in the fabrication of woven fabrics. It causes coloring issues in woven fabrics as well as fabric rejection. The method of fiber ball generation during weaving has been described in this article. The advancements in the weaving process that are required to prevent ball formation and to weave virtually flawless cloth have also been explored.

Keywords: Weaving; Ball formation; Woven fabric; Sizing; Heald wire; Bumping

1. Introduction

Woven fabric is created on the loom by generating interlacement between the warp and weft in accordance with the fabric’s pattern [1]. During weaving, balls develop on the cloth surface due to poor sizing [2]. The development of fuzzy balls was most likely caused by abrasion of the warp yarn (yarn-against-yarn and yarn-against-loom-components) and dissolution of the warp threads amid weaving [3]. The yarn disintegration was most likely caused by the yarns losing part of their twists [4].

2. Background and Related Literature

Sizing is the method of putting a special covering to the surface of warp yarn. Sizing applied to the warps, on the other hand, can boost weaving efficiency by preventing any broken ends from peeling back at the heddles or reeds, generating fuzz balls, and, finally, yarn breakage [2]. Broken ends may potentially obstruct the route of the filling yarn, resulting in a warp-related filling halt [4]. Spun yarns can be hairy and have some fragmented strands, which can pose complications during weaving. Cracked fibers can pose problems during weaving by becoming entangled in loom components and forcing them to “peel back” until a ball is formed, resulting in a break in the yarn and loom shutdowns [5]. If the yarn is not appropriately sized, it causes trouble and has a propensity to form balls [6].
A ball, often known informally as a bobble or fuzz-ball, is a little ball of fibers that develops on a piece of fabric. It occurs when fabric processing causes slack fibers to protrude from the fabric's surface, and abrasion induces the fibers to form into tiny spherical bundles held to the fabric's surface by projecting fibers that haven't broken [7].

Appropriate changes in size ratios and shed geometry resulted in enhanced fiber lay and yarn surface qualities for increased productivity and quality without adding raw material costs on new high-speed shuttle-less weaving techniques [8].

Initially, the warp breaks lessen as the size add-on level increases. This is due to the increased yarn strength and decreased yarn hairiness [2]. The application of the protective size layer around the yarn improves abrasion resistance and offers appropriate protection to the yarn's weak points [10]. With increasing size add-on, the reduction in warp breaking rate approaches a limit beyond which additional size add-on will not result in a meaningful improvement in yarn performance on the loom. When the warp breakage rate is at its lowest, weaving efficiency, which is inversely related to warp yarn end breakage rate, achieves its peak [11]. As seen in the typical curve in Figure - 3, the appropriate
range of size add-on is generally between points A and B. In fact, increasing the size add-on beyond the optimum has a negative effect on weaving performance because the warp breaks rise [6]. Excessive size add-on causes the size to penetrate further into the yarn, making it rigid. Furthermore, an increased size add-on may coat the yarn with a very thick layer of the size that is not suitably attached to the fibers [2]. When compared to the extensibility of the warp yarn, a thick coating of size film may have lesser extensibility. The inflexibility of the yarn and a loosely bonded size film result in size film shedding owing to facile rupturing, rendering the yarn prone to vigorous abrasion action and a greater warp breaking rate [10]. In reality, the best weaving efficiency area consistent with optimal size add-on is generally attained by trial and error [12]. Short fibers stick to the yarn surface and tend to cluster balls if sizing is not handled effectively [13].

![Figure 3 Sizing–Weaving Curve](image_url)

3. **Methodology**

The approach used here is based on several loom settings. It was noticed how the loom settings decrease ball formation on yarn and cloth, and the best settings were computed.

The items listed below were used to carry out the experiment.

**Table 1 Materials**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sizing Machine</td>
<td>Brand: Karl Mayer</td>
</tr>
<tr>
<td>Airjet Loom</td>
<td>Brand: Picanol Omni Plus 800</td>
</tr>
<tr>
<td>Heald wire</td>
<td>Brand: Blue Star</td>
</tr>
<tr>
<td>Weave type</td>
<td>Twill</td>
</tr>
<tr>
<td>Total number of ends</td>
<td>5626</td>
</tr>
<tr>
<td>Width of the reed</td>
<td>1669 mm</td>
</tr>
</tbody>
</table>
The following factors were manipulated in this work to observe their impacts on ball formation.

- Warp tension
- Back-rest height (shed asymmetry)
- Effect of dropper height
- Heald wire settings
- Position of easing arm
- Change in reed count
- Effect of changing shed geometry and shed angle

4. Results and Discussion

Following features were altered in this study, and their effects on ball formation were explored.

4.1 Warp Tension

Figure 4 Important Loom Components and Significant Abrasion Locations

Figure 5 Adjustment of Backrest Position and Height
Low warp tension during fabric manufacturing produces stickiness, which causes an unclear route for the filling. While high tension causes yarn breakage, low tension does not [14]. Consistent and uniform warp tension over the width of the warp during the weaving operation was maintained. Identifying and managing the optimal warp tension increased weaving efficiency and fabric quality.

4.2 Backrest Height
The Backrest roller is an important component of the weaving machine. Several looms were examined in order to determine the best backrest tension. The experiment was carried out using an identical set of backrest height, dropper location, and dropper height. The backrest roller was adjusted up and down while the backrest position, dropper position, and height remained unchanged. It was noticed that fabric quality is dependent on the backrest roller's appropriate adjustment.

4.3 Changing Dropper Position
The distance between the dropper and the backrest roller is referred to as the dropper position. The dropper line connects the backrest or heald frame horizontally. Dropper depth is determined by the distance between the dropper line and the heald frame (Figure 6). All factors except the dropper position were held constant to evaluate the impact of changing the dropper location. It was learned that appropriate adjustment of this setting is beneficial in eradicating the ball formation problem and improving fabric quality.

4.4 Effect of Changing Dropper Height

![Figure 6 Adjustment of Dropper Position and Height](image1)

![Figure 7 Changing the Dropper Height](image2)
The dropper line can be shifted either up or down. The dropper height increases as the dropper line moves upward, and the backrest height decreases as the dropper line moves downward (Figure 7). However, it has been noticed that if the dropper line is situated closer to the heald frame, the influence of the dropper location negates the scenario.

4.5 Effect of Using Duplex Heald Wire Instead of Simplex Heald Wire (Visual Assessment)

Since duplex two-heald wires have more space between them yarns can travel through them more easily and friction among neighboring yarns is minimized. As a result, the tendency to create balls is diminished.

When comparing samples 1 and 2 of the same fabric structure and yarn count, it is clear that the amount of ball created has been reduced due to the use of duplex heald wire rather than simplex heald wire.

4.6 Effect of Changing the Position of Easing Arm (Visual Assessment)

Backrest roller bumping might well be enhanced by adjusting the position of the easing arm [15]. It results in greater jerking on the warp yarn. As a result, the short fibers of various yarns come into less touch with each other, and the inclination to create balls is lessened.
4.7 Effect of Changing Reed Count or Ends per Dent (Visual Assessment)

Reduced reed count or the number of endings per dent in reed dents can also help to minimize yarn friction. As a result, short-hairy fibers do not come into contact with one another, resulting in nearly no fiber balls in the fabric.

4.8 Effect of changing Shed Geometry and Shed Angle (Visual Assessment)

Backrest roller height and depth with drop wire height may be adjusted to obtain desired shed structure [8]. The shed angle may be controlled by altering the heald frame height. When the shed angle was raised to the optimal amount for the fabric structure and yarn count, warp yarn jamming was reduced. As a consequence, friction was minimized, and ball formation was also reduced.

5. Conclusion

However, by adjusting the reed count and heald wire setting, as well as choosing the best shed topology, warp yarn jerking may be enhanced, resulting in extra size materials being detached from the yarn and a reduction in ball formation on the fabric. In order to undertake a quantitative study of the observations on how the remedial activities are fulfilling the weaving section, the subsequent line of research will require a statistical approach with an adequate sample strategy. This study will provide textile specialists with a thorough grasp of the reasons for ball formation on fabric, as well as a conceptual understanding of how to resolve the issue.
Compliance with ethical standards

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Disclosure of conflict of interest

The authors have no conflicts of interest to declare. All co-authors have seen and agreed with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

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