DESIGN AND DEVELOPMENT OF YRAN ABRASION RESISTANCE TESTER

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ABSTRACT

The present project, titled "Design and Development of Yarn Abrasion Resistance Tester", focuses on the development of a compact, cost-effective, and automated system for evaluating the abrasion resistance of yarn under controlled laboratory conditions. Abrasion resistance is a critical mechanical property that significantly influences the durability, performance, and service life of yarns in textile applications such as weaving, knitting, and finishing. Conventional abrasion testing machines are often expensive, bulky, and lack real-time monitoring capabilities, making them less accessible for academic institutions and small-scale industries.

To address these limitations, the proposed system integrates mechanical design with embedded electronics to create an efficient and user-friendly testing device. The system employs a 60 RPM DC gear motor to rotate an emery sheet-covered shaft, which generates controlled abrasion on the yarn specimen. The yarn is held under constant tension between two supports, ensuring uniform testing conditions. An ESP8266 microcontroller serves as the central control unit, enabling real-time monitoring, data processing, and system automation.

A limit switch mechanism is incorporated for automatic yarn break detection. Upon yarn failure, the system immediately stops the motor using a relay control, ensuring precise measurement of critical parameters such as time to break, number of abrasion cycles, and total abrasion distance. These parameters are displayed on a 16×2 LCD interface, providing clear and instant feedback to the user.

The developed system offers several advantages, including low cost, portability, automation, improved accuracy, and reduced human intervention. The prototype demonstrates reliable performance and consistent results, making it highly suitable for educational institutions, research laboratories, and small-scale textile industries. This project contributes to the advancement of smart textile testing equipment by providing an accessible and efficient solution for evaluating yarn abrasion resistance.

Keyword : - *Yarn Abrasion, Abrasion Resistance, mechanical property, and Yarn property etc….*

1. INTRODUCTION

The performance and durability of textile materials are highly dependent on the mechanical properties of yarn, among which abrasion resistance plays a vital role. During textile manufacturing processes such as weaving, knitting, and finishing, yarns are continuously subjected to frictional forces due to repeated contact with machine components, other yarns, and guiding elements. This continuous abrasion leads to gradual wear, reduction in tensile strength, and eventual yarn breakage. Such breakages not only interrupt production but also affect fabric quality, efficiency, and overall manufacturing cost [21].

Abrasion resistance is therefore considered a key parameter in determining the suitability of yarn for specific applications. Yarns with poor abrasion resistance tend to fail prematurely under operational conditions, resulting in increased downtime and reduced productivity. Hence, accurate evaluation of yarn abrasion behaviour is essential for quality control, process optimization, and product development in the textile industry [10].

Traditional yarn abrasion testing machines, such as Zweigle and WIRA testers, are widely used for this purpose. However, these machines are often expensive, bulky, and require skilled operation. As reported by Stoll [1], early abrasion testing systems were designed to provide controlled friction, but modern requirements demand improved automation and accuracy. In addition, many of these systems lack automation, real-time monitoring, and digital data recording capabilities. Manual observation of yarn breakage introduces inconsistencies and human errors, affecting the reliability and repeatability of test results [2]. These limitations make conventional systems less suitable for academic institutions and small-scale laboratories.

With the advancement of embedded systems and automation technologies, there is a growing need to develop modern testing equipment that is compact, cost-effective, and capable of delivering accurate and consistent results. According to Textor et al. [2], understanding abrasion mechanisms and improving testing methods are essential for reliable evaluation. In this context, the present project focuses on the design and development of an automated Yarn Abrasion Resistance Tester. The system integrates mechanical components with an ESP8266 microcontroller to enable controlled abrasion, real-time monitoring, and automatic yarn break detection.

The proposed system utilizes a motor-driven emery sheet-covered shaft to simulate abrasion conditions, while maintaining constant tension on the yarn specimen. Studies by Li et al. [3] indicate that controlled testing conditions and material properties significantly influence abrasion performance. The integration of sensors, control units, and display systems ensures precise measurement of parameters such as abrasion cycles, time to failure, and abrasion distance. By automating the testing process, the system minimizes human intervention, enhances accuracy, and improves efficiency.

This project aims to bridge the gap between conventional testing methods and modern technological requirements by providing an affordable, reliable, and user-friendly solution for evaluating yarn abrasion resistance. It holds significant potential for application in educational institutions, research laboratories, and small-scale textile industries, contributing to improved quality control and innovation in textile testing.

1.1 Problem Statement

Abrasion resistance is a critical parameter that determines the durability and performance of yarns in textile manufacturing processes. During operations such as weaving and knitting, yarns are subjected to continuous friction, leading to wear, strength reduction, and eventual breakage. Accurate evaluation of this property is essential for ensuring product quality and minimizing production losses.

However, existing yarn abrasion testing methods have several limitations. Conventional systems are expensive, bulky, and not easily accessible for academic institutions and small-scale laboratories. They often lack automation and rely on manual observation for yarn break detection, leading to human errors and inconsistent results. Maintaining constant parameters such as tension and abrasion speed is also difficult, affecting reliability.

Additionally, the absence of real-time monitoring and digital data recording makes it challenging to measure parameters like time to break, number of cycles, and abrasion distance. Most systems are limited to single-sample testing, reducing efficiency. These challenges highlight the need for a compact, cost-effective, and automated yarn abrasion tester capable of providing accurate results with minimal human intervention.

1.2 Objective

The primary objective of this project is to design and develop an automated Yarn Abrasion Resistance Tester capable of accurately evaluating yarn abrasion performance under controlled conditions. The system integrates mechanical and electronic components to ensure reliable, repeatable, and efficient testing.

The specific objectives are as follows:

- To develop a compact and cost-effective testing machine suitable for laboratory and academic use.
- To maintain controlled and constant tension on the yarn during testing.
- To generate uniform abrasion using a motor-driven emery sheet-covered shaft.
- To measure key parameters such as time to break, abrasion cycles, and abrasion distance.
- To implement automatic yarn break detection using a limit switch.
- To automate the system using an ESP8266 microcontroller for improved accuracy and reduced human intervention.
- To provide real-time data display using a 16×2 LCD interface.

2. METHODOLOGY

The methodology involves the design, fabrication, and operation of the Yarn Abrasion Resistance Tester using a systematic approach.

A rigid support frame is developed to hold all components in alignment, with adjustable jaws to secure the yarn under constant tension. The abrasion mechanism uses a rotating shaft driven by a DC gear motor, covered with an emery sheet to generate friction. The motor runs at a constant speed to ensure uniform abrasion during testing.

When the system is started using a push button, the motor rotates the shaft, and the yarn undergoes continuous abrasion. The ESP8266 microcontroller monitors parameters such as rotational speed and number of revolutions.

A limit switch detects yarn breakage and signals the controller to stop the motor instantly via a relay, ensuring precise measurement of failure.

The system records parameters like time to break, abrasion cycles, and abrasion distance, displaying them in real time on an LCD. This approach ensures controlled testing, reduces human error, and provides reliable and repeatable results.

2.1 Materials Used

Table -1: Component Spec

Component	Specification	Function
ESP8266 Microcontroller	3.3V, Wi-Fi enabled	Control unit
DC Gear Motor	12V, 60 RPM	Rotation of shaft
Emery Sheet Roller	P180–P220 grade	Abrasion generation
Limit Switch	5V mechanical switch	Break detection
Relay Module	5V control, 12V switching	Motor control
LCD Display	16×2	Output display
Voltage Regulator	7805	Voltage stabilization

2.2 Trial Run Results

Table -2: Observation Table

Sample	Yarn Type	Time (sec)	RPM	Cycles	Distance (mm)
1	Cotton	5.34	60	5	839
2	Polyester	8.46	60	8	1328
3	Blend	7..21	60	7	1131

3. PERFORMANCE OF THE DEVELOPED SYSTEM

The fabricated prototype of the Yarn Abrasion Resistance Tester was tested using different yarn samples to evaluate its functionality and reliability. The system successfully demonstrated smooth operation of all integrated components, including the motor-driven abrasion shaft, limit switch mechanism, and real-time display unit.

The 60 RPM DC gear motor provided stable and uniform rotational motion throughout the testing process. The

emery sheet-covered shaft generated consistent abrasion on the yarn surface, closely simulating real-life frictional conditions encountered during textile manufacturing processes. The use of ball bearings ensured minimal vibration and smooth rotation, which contributed to the accuracy of the test results.

The ESP8266 microcontroller effectively controlled the entire system by monitoring operational parameters and executing commands. The relay module responded promptly to control signals, ensuring safe and reliable switching of the motor. The LCD display unit provided continuous updates of parameters such as time duration, number of revolutions, and test status, enhancing user interaction and ease of operation.

3.1 Yarn break detection and system response

One of the key features of the developed system is the automatic yarn break detection mechanism. The limit switch was strategically positioned to detect the presence of the yarn specimen during testing. When the yarn remained intact, the switch maintained its engaged position. Upon yarn breakage, the switch was released, generating an immediate signal to the microcontroller.

The response time of the system was observed to be minimal, with the motor stopping almost instantaneously after yarn failure. This ensured that the final readings, such as time to break and number of abrasion cycles, were recorded accurately without any delay. The automatic cutoff mechanism eliminated the need for manual observation, thereby reducing human error and improving measurement precision.

4. CONCLUSIONS

The project successfully achieved the design and development of an automated Yarn Abrasion Resistance Tester for evaluating yarn performance under controlled conditions. The system integrates mechanical components with embedded electronics, resulting in a compact, cost-effective, and efficient testing device.

The tester simulates real-life abrasion using a motor-driven emery sheet-covered shaft, with a constant speed DC gear motor ensuring uniform abrasion. Controlled yarn tension and the use of ball bearings enhance stability and accuracy. An automated yarn break detection system using a limit switch enables immediate motor stoppage through a relay, ensuring precise measurement of parameters such as time to break and abrasion cycles.

The ESP8266 microcontroller manages system operations, enabling real-time monitoring and control, while a 16×2 LCD provides clear display of test parameters. Experimental results confirm that the system delivers reliable, repeatable results with reduced human intervention and improved efficiency.

Although the system has limitations such as manual tension control and single-sample testing, it offers a practical, affordable, and automated solution for yarn abrasion testing. It effectively bridges the gap between conventional methods and modern requirements, making it suitable for educational institutions, research labs, and small-scale industries.

5. REFERENCES

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