

Geometrical and Mathematical Analysis of the Elongation of Woven Fabric Structures

Said Sobhey Badawi

Associate Professor of Weaving Technology at the Dept. of Textiles at the Faculty of Applied Arts, Helwan University, Cairo (Egypt), saidsobhey@hotmail.com.

Abstract:

It is very important when choosing a textile material to consider that the fiber and yarn structure types meet the functional requirements of the end-use product. Therefore, their choice will particularly influence the fabric's chemical, physical, and mechanical behaviors. In the shadow of a world dominated by scarcity and/or high cost of raw materials, specialists in all fields of textiles must seriously research and develop new alternatives that can be used in manufacturing operations. The raw material's poor physical properties, especially the elongation property, usually lead to its exclusion from use. Theoretically, it is not feasible for use in textile fields. As it is known, yarn elongation has deep effects during production operations and for final use. Also, some of the raw materials that are already used need to develop their production methods, to reduce waste rates and make better use of materials. This is achieved by studying the behaviors of these textile materials during manufacturing and processing operations to monitor the effectiveness of their physical properties on the quality of operations. For professionals in the field of textile engineering, the study of this important physical property comes at the heart of our scientific research interest. That is due to its close connection with all textile processes. Where the elongation of textile material plays an active role in the quality of the operating processes, starting from the initial operation stages until the final processing stage, passing through the weaving process, which is the focus of this research study. In addition, the elongation feature is associated with many other properties associated with the end uses, including properties, such as drapability, flexibility, recovery, and comfort, all of which make it suitable for use as a material for clothing and other uses. Although much research was achieved in the past to relate weave structure to the mechanical characteristics of woven fabrics, they were lacking in detail and did not offer relevant insights. These studies relied on the interpretation of elongation based on the test results and did not really penetrate the behavior of the sample under the influence of stress during the test. Therefore, this paper focuses on the study of elongation based on previous engineering concepts of the interlacing shape of the Peirce concept which is the closest geometric figure to the structure of the woven fabric, especially using synthetic fibres due to its regularity compared to other natural fibers. This research study also focused on studying the characteristic of yarn elongation from both theoretical and practical perspectives, based on the scientific importance of that physical property related, especially concerning the acceptance or rejection of the use of the material in the textile fields.

Keywords:

Weaving parameters, Yarn diameter, Weft density, Crimp, Extension, Fabric elongation, Weight, Fabric construction, Fabric thickness, Cover factor, Tensile strength.

References:

1. **Peirce, F.T.:** Geometry of cloth structure. Journal of the Textile Institute. Manchester, (1937). Vol. 28 No.3, pp.T45.
2. **Peirce, F.T.:** Geometrical Principles Applicable to the Design of Functional Fabrics. Textile Research Journal, (1947). Vol. 17, No. 3, pp.123.
3. **Chen, Xiaogang:** Modelling and Predicting Textile Behaviour. Cambridge, UK: Woodhead Publishing, 2010. – ISBN 978-1-84569-416-6
4. **B.K. Behera and P.K. Hari:** Woven Structure Theory and Applications Textile. Cambridge, UK: Woodhead Publishing, 2010. – ISBN 9-781-84569-514-9
5. **Heinz Hollstein, Hanskarl Hahn und Rolf Meixner:** Fertigungstechnik Weberei: Mechanismen zur Gewebefbildung, Bd 2. Leipzig Germany: Fachbuchverl., 1987. – ISBN 3-34300-338-7
6. **R. Marks and A.T.C. Robinson:** Principles of Weaving. Manchester, UK: Journal of the Textile Institute, 1986. – ISBN 0-900-73979-7

Paper History:

Paper received February 5, 2023, Accepted April 14, 2023, Published on line May 1, 2023