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Investigating Garment Drape Behaviour

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Abstract

Drapeability is one of the most important visual properties affecting garment appearance. Even though there are many studies concerned with fabric drape, understanding about the drape behaviour of garments is very limited. This study analyzes the key properties affecting the drape behaviour of garments to provide prediction equations. Results are statistically analyzed. From multiple regression analysis, drape rank scores obtained from subjective analyses are predicted using weight, bending modulus and extensibility measured at 100 gf/cm with a correlation coefficient of 0.94. Ranking values obtained from subjective analyses can be more easily predicted using both circularity and wave length minimum. A new equation was derived to predict drape rank score values of garments (correlation coefficient $r = 0.97$) depending on circularity and wavelength minimum.

Keywords: Drape; Fabric; Garment; Prediction; Visual; FAST; Mechanical; Parameters

1 Introduction

With the advent of fast fashion it is becoming ever more important that designers and technologist be able to predict garment appearance and this is significantly influenced by drape. This is the manner in which a fabric or garment makes folds under the effect of gravity when only part of it is directly supported.

Measurement of fabric drape objectively has long been the concern of textile researchers. The Fabric Research Laboratories Drapemeter (F.R.L.) described by Chu *et al.* in 1950 was the first apparatus developed considering drape as a three dimensional property [1]. Later in 1965, Cusick made a great contribution to the measurement of fabric drape objectively [2]. Since then, there has been much further development of drapemeters employed in measuring fabric drape. The standard method for measuring drape is based on Cusick's work. The development of the drapemeter from the early beginning until the latest improvement is comprehensively reviewed by Sanad *et al.* in 2012 [3].

Drape is a complex property and it is an essential parameter to decide both appearance and handle of fabrics. Textile researchers have been interested in investigating drape because of the

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attempt to create more successful clothing CAD systems by introducing key fabric properties affecting garment drape.

Drape was found dependent on fabric physical and low stress mechanical properties. Therefore, researchers worked on establishing the relationship between drape and these properties. Theoretical prediction has been employed by researchers to identify key factors which contribute to drapeability.

2 Literature Review

Chu *et al.* in 1960 found that drapeability is dependent on three basic parameters: Young's Modulus E, the cross-sectional moment of inertia (I) and weight (W). These factors play important roles in fibre, yarn, and fabric forms. The effect of these quantities on drapeability was expressed as follows: Drape coefficient = f(EI/W) [4].

Cusick in 1965 provided statistical evidence that the fabric drape coefficient is dependent on shear stiffness (A) and bending length (c). Regression equations to describe this relation quantitatively were introduced. The model included a combination of 4 variables c, c^2, A and A^2 had the lowest residual value. This means that it was the best one fitted to the data [2].

Hearle in 1969 analyzed the nature of fabric deformation in draping. He stated that bending and shear are the main factors affecting drape. Buckling behaviour was also important in determining the form and magnitude of drape but it is related to bending stiffness. He ignored tensile and compressive deformation as these are not comparable to bending and shear deformation [5].

Morooka and Niwa in 1976 stated that they had found no investigation studying the relation between physical properties, other than bending and shear stiffness, and drape coefficient. Therefore they examined a variety of sixteen physical and mechanical properties of woven fabrics measured on a Kawabata Evaluation System (KES-F) contributing to drapeability. Bending rigidity BR and weight per unit area W were the most determinative parameters to drape coefficient, and better agreement was obtained between experimental results and a regression calculation when these are combined in a single parameter $\sqrt[3]{BR/W}$ [6].

Gaucher *et al.* found that several physical properties were suggested as contributors to the drape of woven fabrics but literature lacks information concerning physical properties influencing the drape of knitted fabrics. Therefore, they carried out multiple regression analysis to predict warp and weft knitted fabric drape coefficients using physical and mechanical properties. It was observed that using a mechanical property value of different face direction, or average of both resulted in prediction equations with different reliability degrees. The overall mean did not always exist in the best predictive equation. Warp knits and weft knits, however, were dependent on different variables. Stiffness, measured in terms of bending length, thickness, and shear, was the factor influencing the drape of knitted fabrics in general. Stiffness, thickness, and extension were the best predictors for warp knits, whereas stiffness and shear were the best predictors for weft knitted constructions [7].

Collier in 1991 measured the drape coefficient of a group of woven tested fabrics using different-sized pedestal plates (3 and 5 inches diameter). Stepwise multiple regression was performed for drape coefficient on fabric mechanical properties. Shear hysteresis and bending resistance measured on a KES-F were found to be more closely associated with fabric drape than were thickness and weight. Descriptive mechanical properties were dependant on pedestal size. Bending modulus