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Correlation Analysis Between Comfort and Mechanical Properties of Sports Fabrics

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Abstract

Given the time-consuming and costly measurement of heat-moisture comfort indexes and the difficulty of quantifying contact comfort, 20 sports fabrics were tested for air permeability, moisture permeability, thermal resistance, moisture resistance, sensory evaluation indicators and 18 mechanical parameters. Then, the correlation between contact comfort indexes and mechanical parameters was analysed. On this basis, multiple linear regression prediction models for thermal resistance, moisture resistance and contact comfort indexes of sports fabrics were established. The results show that the thermal resistance of sports fabrics can be predicted by Compression work (CW) and Compression recovery rate (CRR) indicators, and the moisture resistance can be predicted by Bending work in the warp (BWa) and CRR indicators. The smoothness of sports fabrics can be predicted by CW and Compression stiffness (CAR), the softness by Bending work in weft (BWe) and CAR, the warmth by CW, BWe and Surface friction coefficient in weft (SFCe), and the combined feeling by Bwe and CAR. The models were also validated and are considered to have practical implications for companies and consumers when assessing and improving the comfort of sports fabrics.

Keywords: Sports Fabrics; Heat-moisture Comfort; Contact Comfort; Mechanical Properties; Regression Models

1 Introduction

In recent years, the impact of the pandemic has enhanced people's health consciousness and emphasis on sports and fitness, thus ushering in a major development in the sportswear market. At the same time, the rising standard of living has led to a rising demand for comfort in sports fabrics. Fabric comfort includes heat-moisture comfort, contact comfort, and aesthetic comfort. For sports fabrics, heat-moisture comfort is directly related to the performance of professional athletes and the efficiency of general public gym-goers, which is a very important indicator [1, 2]. Most sportswear has a large contact area with the human body, and various mechanical and chemical stimuli are generated between the human skin and the fabric during the movement to

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affect the comfort level. Hence, its contact comfort is equally important. At present, research has focused on the influence of basic fabric parameters such as fabric raw materials [3], fibre parameters [4], blending ratios [5], and tissue structure [6] on fabric comfort. However, there is little research on the relationship between fabric comfort and mechanical properties. Kim et al. [7] used a thermodynamic index (Qmax) to evaluate the comfort of underwear fabrics but only examined the relationship between heat-moisture comfort and each factor rather than developing models of heat-moisture comfort evaluation index [8-10].

Testing fabric comfort is generally done by physiological and subjective experiments, which are tedious and affected by individual subject differences. The experiments are, therefore, not reproducible. Some scholars also use predictive software such as CAD to test garments' heat-moisture comfort [11, 12]. As well as the evaluation of fabric softness and hand-feel values [13, 14]. This paper's focus on fabric comfort is on heat-moisture comfort and contact comfort. Directly testing the fabric comfort indexes requires high-cost instruments and is time-consuming. The indirect evaluation of the fabric comfort requires information on fibre composition, structural, dyeing and finishing processes, but this information is difficult to obtain. This paper does not need to use the above data. It will only use the finished fabrics to measure the relevant data with objective, accurate, and fast physical measuring instruments to evaluate the fabric's comfort. This will greatly improve the convenience and application range.

2 Experiment

2.1 Experimental Samples and Indicators

Twenty pieces of sports fabrics on the market (labelled as 1#, 2#, 3#, $\cdots$, 20#) are used for the experiments and classified according to their use [15]. Their information is shown in Table 1. Data from Ref. [16].

Table 1: Basic information about fabrics

No.	Ingredients	Thickness/mm	Usage	No.	Ingredients	Thickness/mm	Usage
1#	T	0.02	Casual jacket	11#	T/SP	0.66	Yoga Clothing
2#	T	0.92	Casual jacket	12#	T	0.63	Jersey
3#	R/T/SP	0.82	Casual jacket	13#	N/SP/T	0.44	Jersey
4#	N	0.07	Casual jacket	14#	T	0.39	Jersey
5#	T/SP	0.81	Jersey	15#	N/SP	0.51	Yoga Clothing
6#	T/SP	0.59	Jersey	16#	T	0.49	Yoga Clothing
7#	C/N/SP	1.33	Casual jacket	17#	T/SP	0.47	Yoga Clothing
8#	T/SP	0.49	Yoga Clothing	18#	M/T	0.38	Casual T-shirt
9#	C/SP	0.73	Casual T-shirt	19#	T/R	0.36	Casual T-shirt
10#	T/SP	0.84	Casual jacket	20#	N/SP/T	0.41	Jersey

Natural fibres: C - Cotton, W - Wool; Recycled fibres: M - Modal, V - Viscose, R - Rayon, B - Bamboo; Synthetic fibres: T - Polyester, N - Nylon, SP - Spandex.