

Analysis of Mechanical Properties of Basalt Hybrid Woven Fabrics

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Abstract

Textiles applications in technical area is one of the imperative subjects in present time. Application of textiles in various fields especially in protective garments application is increasing day by day. The objective of this work is to evaluate and discover the effect of fiber and structure on tensile and dynamic mechanical properties of hybrid and non-hybrid basalt structures. This work deals with the study of the mechanical properties of woven fabrics in relation to fiber and weave. In this study, investigative experiments are carried out to find out the static and dynamic mechanical behaviour of Basalt/Polyester (B/PET) and Basalt /Polypropylen (B/PP) fibre hybrid woven and non-hybrid woven fabric. Three types of weaves are used i.e. Plain (PW), Matt (MW) and 1/3 Twill (TW) for hybrid and non-hybrid structures respectively. The tensile testing of all the woven fabric specimens is carried out. The discussion of results is in terms of fibre effect and woven geometry. The exposure of fabrics to increasing temperature is beneficial to their mechanical properties and performance. The dynamic mechanical analysis exhibits a rise in storage modulus. It indicates a lower damping and higher stiffness ratio in hybrid fabrics. These fabrics can be used for temperature resistant applications and in composites.

Keywords: Basalt; Protective garments; Hybrid; Woven; Storage modulus

1 Introduction

In present scenario, life is so fast and human standards are increasing with every day passing by. People are becoming more demanding and well aware about their need. People are becoming specific with the level of comfort or specifications of textile material regarding end use. The issue of safety, environment and health are considered, important now a days. Public awareness and concern about the negative effects of pollution has led consumers to favour environmentally friendly materials, less contaminating processes, and recycled products. Thus, environmentally friendly materials of high flame resistance and good mechanical properties are in need. People are well aware with the need of having environment friendly products which is leading to invent of new environment friendly fibres.

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Basalt is a fibre that gives solution to need of environment friendly material. The origin of basalt fibre is rock of basalt that was known long ago for its thermal properties, durability and strength. This rock is used for production of basalt fibres. The basalt raw material has a low extraction cost. It has a safe and easy process for production. The methodology used to produce basalt is environment friendly and simple. I.e. no harmful emission or waste production during the production process, in addition to this it does not react with water. Basalt is termed as green industrial material. As basalt is made of natural material so it falls under sustainable material class. Basalt is harmless both environmentally and ecologically. It is free of carcinogens and other health hazard. Basalt has replaced asbestos, as it was potentially hazardous to respiratory system. Basalt can replace glass in many applications because of its advantage of possessing environment friendly [1-2].

Fabrics can be produced with different techniques with different fibres. The fabrics made from interlaced yarn falls under most common yet complex technique. It is most tradition method of fabric formation. Most common and famous example of interlacement of yarns to produce fabric is weaving in which two sets of yarns interlace and interweave to complete fabric production process. The force that holds the two sets of yarns together is inter-yarn friction. Woven fabrics have been utilized commercially for energy absorption, aerospace, defence, automotive parts, and structural applications because of their high strength and stiffness.

For special applications with affordable costs, hybrid structures are used. Two sets of yarns that are used in hybrid structures make it possible to form a material that may possess combined properties of both the material and it provides the flexibility to mitigate non desirable properties. It makes possible, tailoring of properties as per specific requirements.

In the research, basalt yarn with thermoplastic yarns are used. This research has a focus on mechanical properties of yarns, which are produced with fibers of basalt and woven fabrics, made from yarns by using them in warp and weft directions respectively. The knowledge of mechanical properties is of wider importance as it will be most important factor in consideration during designing of fabrics for industrial uses. In high tech. applications, most importance properties associated with fabric performance are Strength, modulus, and elongation. Protection applications like gloves can be one of many uses of these fabrics. On the basis of end application and requirements related to function, the dynamic mechanical properties were investigate to study the effect, with addition of basalt fibers. The results of measurements were statistically analyzed by ANOVA and found to be significantly different. It is hoped that the result can provide scientific guidance for the development and the design of protective applications and composite structures.

2 Material & Methods

2.1 Material

Raw materials involved in this study were woven hybrid and non-hybrid fabrics made from basalt, Polypropylene (PP) and Polyester (PET). Total of 27 samples were made on CCI Sample loom with same thread density i.e 12 ends/cm and 7 picks/cm. The polyester (PET), which was used in our study, was commercially available. Synthetic (Pakistan) is producer of Polypropylene (PP) yarn where as basalt yarn that we used was received from the company Kamenny Vek (KV) (Russia). Polyester fibres (PET) is main synthetic fibre which is used in the industrial