



Design of Three-Dimensional Braided Fabrics and its Technology

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Received date: 22 March, 2023, Manuscript No. JFTTE-23-99155;

Editor assigned date: 24 March, 2023, PreQC No. JFTTE-23-99155(PQ);

Reviewed date: 15 April, 2023, QC.No JFTTE-23-99155;

Revised date: 22 April, 2023, Manuscript No. JFTTE-23-99155(R);

Published date: 28 April, 2023, DOI: 10.4172/2329-9568.1000295.

Description

Three-dimensional braided fabrics are an innovative class of textile materials that possess remarkable structural integrity and enhanced mechanical properties. These fabrics are characterized by their unique architecture, where multiple sets of yarns interlace in three dimensions, resulting in a highly interconnected and stable structure. The use of 3D braided fabrics has gained significant attention in various industries, including aerospace, automotive, sports, and biomedical, due to their exceptional strength, durability, and design flexibility.

Architecture of three-dimensional braided fabrics

The architecture of 3D braided fabrics is the key factor behind their exceptional mechanical properties. Unlike traditional two-dimensional fabrics, which consist of interlaced yarns in two perpendicular directions (warp and weft), 3D braided fabrics involve multiple sets of yarns interlacing in three dimensions. This unique architecture allows for the formation of a highly integrated structure that exhibits superior load-bearing capabilities.

The primary components of a 3D braided fabric include the axial yarns, bias yarns, and binder yarns. The axial yarns run parallel

to the length of the fabric and provide the primary load-bearing capacity. The bias yarns are positioned at an angle relative to the axial yarns and contribute to the overall strength and stability of the fabric. The binder yarns, as the name suggests, hold the structure together and ensure the interconnection between the axial and bias yarns. The specific arrangement and orientation of these yarns can be customized to meet the desired mechanical properties of the fabric. By altering the angles and densities of the bias yarns, fabric engineers can control parameters such as stiffness, strength, and directional properties. This versatility in design enables the production of tailor-made 3D braided fabrics for a wide range of applications.

Technology of three-dimensional braided fabrics

The production of 3D braided fabrics involves advanced textile manufacturing techniques that require precision and expertise. Several methods are commonly employed to manufacture these fabrics, including the flat bed method, circular method, and multi-axial method. The flat bed method utilizes a flat braiding machine where the axial, bias, and binder yarns are interlaced to form the fabric. The machine consists of multiple rows of needles or carriers that move in a predetermined pattern, weaving the yarns together. This method allows for the production of relatively flat and uniform fabrics with excellent mechanical properties. The circular method, as the name suggests, employs a circular braiding machine. This technique is particularly suitable for producing tubular or cylindrical 3D braided fabrics. The yarns are interlaced in a circular motion, forming a seamless structure. This method is widely used in applications such as hoses, sleeves, and other tubular components.

The multi-axial method involves the simultaneous interlacing of multiple sets of yarns in different orientations. This technique enables the production of complex 3D braided fabrics with tailored properties. By combining different fiber types and yarn architectures, fabricators can achieve specific characteristics, such as high strength, impact resistance, or thermal stability. Advanced materials, such as carbon fibers, aramid fibers, and glass fibers, are commonly used in the production of 3D braided fabrics. These materials offer excellent mechanical properties, including high tensile strength, stiffness, and resistance to environmental factors. The choice of materials depends on the intended application and the desired performance requirements.

Citation: Sung H (2023) Design of Three-Dimensional Braided Fabrics and its Technology. J Fashion Technol Textile 11:2.