THREE-DIMENSIONAL WOVEN FABRICS STRUCTURE FOR BALLISTIC PROTECTION

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Abstract: This study explores and discusses the structures of three-dimensional (3D) woven fabric focused on ballistic protection. This study aims to analyze the differences in the internal geometry of 3D multi-woven fabrics on the mechanical properties important for ballistic protection. Selected investigated 3D fabric techniques are from the categories: multilayered warp interlaced fabrics with identical number of layers and different frequency of connecting points in multilayered woven fabrics; orthogonal and angel interlock: through-the-thickness as well as ply-to-ply interlock.

Keywords: *3D woven fabric, ballistics, interlacing, para-aramid.*

INTRODUCTION

The ballistic protection includes vests, body armour, helmets, vehicles structural reinforcement, etc. The linear, planar (2D) and 3D textiles it is possible to use for ballistic protection. 2D and 3D textiles structure category is given by weaving, knitting or nonwoven technologies [1]. The type (knife, hand gun, assault rifle bullet, high-velocity bullet) and level of the threat are considered in design and manufacturing of ballistic protective apparel [2]. High-performance fibers used in ballistic protection are characterized by a low density, high strength, and high energy absorption capability, the most used are para-aramids Twaron, Kevlar, etc. [3].

DESIGN SOLUTION OF 3D WOVEN FABRIC STRUCTURES FOR BALLISTIC PROTECTION

The development of new materials with special properties opens up new possibilities for their utilization in already known technologies, enabling a possible range of innovations from improving the performance and efficiency of existing products to creating entirely new applications that were previously not possible. This study examines the influence of 3D fabric construction on its application in the field of ballistics. It focuses particularly on the analysis of warp and weft interlacement and its impact on the mechanical properties of the fabric, aiming to optimize its use in ballistic vests. The study includes an experimental design of basic three-layered 3D fabrics with various types of interlacing, including non-interlaced with perpendicular and oblique interlacing (Fig.1) with the possibility of using fillers and connectors with different distances between connections.

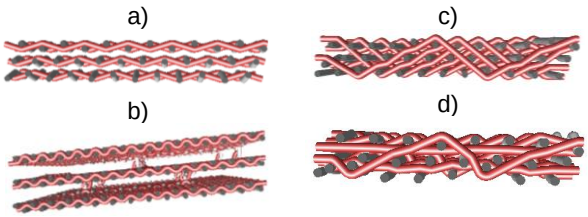

Figure 1 3D woven fabric structures composition, a) multilayered warp interlaced fabrics without connecting points, b) multilayered warp interlaced fabrics with connecting points, c) angel/ply-to-ply interlock, d) orthogonal interlock.

The main part involves setting the structural parameters of the fabrics while maintaining the same warp density so that they can be woven on a dobby shedding mechanism shows Fig. 2.

Figure 2 Rapier weaving machine CCI with dobby shedding mechanism.

Emphasis is placed on the flexibility and durability of the woven fabric, which are crucial for user comfort and protection against projectiles. Through tests of mechanical properties, the study examines how specific structural parameters affect the mechanical properties of the fabric.

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