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Construction of 2D/3D textiles for ballistic protection

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Abstract

This paper reports results on the influence of construction of ballistic fabrics on ballistic performance. Based on preliminary research, a new concept of fabrics with material continuity and enhanced yarn gripping was put forward. Accordingly, fabrics with enhanced yarn gripping were engineered, manufactured, and tested, and results showed improved ballistic performance in terms of both projectile penetration and trauma impact. Based on the new concept, 2D and 3D fabric constructions were discussed for ballistic protection. FE simulation was also carried out for the investigation of strain distribution in the ballistic fabrics, which provides information for optimisation of fabric construction.

Key words: *Textiles, Ballistic protectio, 3D fabric construction*

1. Introduction

Ballistic impact encountered in personal protection is normally a low-mass high-velocity impact onto an assembly of soft and non-homogeneous materials, which is usually woven fabrics made from high performance fibres, such as aramid and high performance polyethylene, by a more rigid projectile travelling at a high velocity. Therefore, ballistic impact represents a complex mechanical process. Since the ballistic impact is a high velocity event, the effect of such impact on the target is most likely to be mainly near the location of impact. The effectiveness of the protective material is measured on two accounts, i.e., the ability to stop projectile from penetrating, and the ability to absorb and migrate the impact energy. The principles of minimizing the effects of energy transfer from a projectile are explained by Cooper and Gotts (2005). Energy transfer can be minimised in two general ways. The first is to promote energy absorption through breaking, stretching, and compressing the protective materials, or by extension of time over which the impact energy is applied to the body. The second is to redistribute or dissipate the impact energy to wider areas of the protective material so as to reduce the impact energy density over the protective material.

Obviously, the effectiveness of the ballistic fabrics mainly depends on the selection high performance fibres, where the high strength and high modulus play important roles. It has to be mentioned that the current choice of fibres of ballistic applications is quite limited. Another obvious route to improve the effectiveness of the ballistic material is to optimise the construction of the ballistic fabrics. This paper reports work from this view point.

2. Background

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