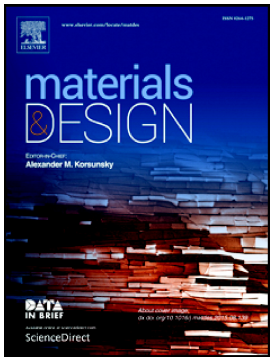
Accepted Manuscript



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PII: S0264-1275(16)31401-0
DOI: doi: 10.1016/j.matdes.2016.11.013
Reference: JMADE 2449

To appear in: *Materials & Design*

Received date: 9 August 2016
Revised date: 28 October 2016
Accepted date: 3 November 2016

Please cite this article as: Yanyan Chu, Shengnan Min, Xiaogang Chen , Numerical study of inter-yarn friction on the failure of fabrics upon ballistic impacts. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Jmade(2016), doi: 10.1016/j.matdes.2016.11.013

Numerical Study of Inter-yarn Friction on the Failure of Fabrics upon Ballistic Impacts

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This paper investigates the influence of inter-yarn friction in fabrics on the ballistic performances of the target including failure. Finite element (FE) method was adopted for the study, where FE models were established for two types of fabrics based on the yarn properties of Twaron® and Dyneema®, respectively. Numerical analyses on the responses of the primary and secondary yarns in the fabrics subjected to ballistic impact were carried out based on these fabric models. The results show that larger inter-yarn friction leads to less slippage of primary yarns at impact centre. In addition, higher inter-yarn friction make more involvement of the secondary yarns join in loading the impact energy, so as to alleviate the loads in primary yarns and prolong the failure of primary yarns. However，if the inter-yarn friction is too high, beyond coefficient of static friction (CSF) of 0.8 and coefficient of kinetic friction (CKF) of 0.75, the action would be counterproductive. The reason is that the stress at those inter-yarn friction levels would be more concentrated on the primary yarns, resulting in an earlier failure of a fabric.

Keywords: Ballistic impact, Inter-yarn friction, fabric, Finite element, Primary yarns, Secondary yarns.

1. Introduction

Fibres with high strength and high stiffness are favourable materials for ballistic protective applications. According to their chemical structures, those fibres are generally classified into three groups, including aramid fibres such as Kevlar® (by DuPont) and Twaron® (by Teijin), ultra-heavy molecular weight polyethylene (UHMWPE) fibres such as Dyneema® (by DSM) and Spectra® (by Honeywell) and Poly-p-phenylene benzobisoxazole (PBO) fibres such as Zylon® (by Toyobo). These fibres can be woven into a fabric structure providing the strength and toughness that substantially surpasses those of individual strands [1]. The impact resistance of the fabrics is generally attributed to various factors,

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