UNIVERSITI TEKNOLOGI MARA

A STUDY ON THE BALLISTIC IMPACT PERFORMANCE OF NEAT AND NATURAL RUBBER LATEX-COATED UNIDIRECTIONAL (NON-WOVEN) HIGH STRENGTH FABRICS

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Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Applied Sciences

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a panel of examiners has met on 16th March 2015 to conduct the final examination of Normala Binti Hassim on her Doctor of Philosophy thesis entitled "A Study on the Ballistic Impact Performance of Neat and Natural Rubber Latex-Coated Unidirectional (Non-woven) High Strength Fabrics" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

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I declare that the work in this thesis/dissertation was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

This research explores the application of natural rubber (NR) latex as a thin coating matrix on unidirectional (UD) fabrics for ballistic impact applications. Pre-vulcanised NR lattices were used to coat ballistic fabrics mainly by the single dip method and half dip method. It was found that NR latex changes the frictional aspects among the fibers attached with thin polyethylene film in the coated fabrics. The NR latex film was able to bind the polyethylene film, restrict mobility and share in resisting load applied to the fabric. In particular, an increase in friction was evident from the higher tensile, tearing and puncture resistance of the NR latex coated fabrics in comparison with neat fabrics. In the ballistic impact tests, utilizing several NR latex-coated fabrics in a fabric system increases the ballistic limit as high as 65% in comparisons with all-neat fabric system. The single dip coating technique gave higher ballistic limit value than the all-neat and other types of coating technique which was fired by Full Metal Jacketed Round Nose bullet. Somehow, the half dip coating method has the potential for ballistic applications because of the slight increase in the ballistic limit of a 12-layer fabric system. In subsequent tests, as high 23% in blunt trauma reduction was achieved using 4 NR latex-coated layers in the fabric system. The main deformation modes were small deflection or ballistic punch and peeling off of the NR latex film at the impact point. Neat fabrics failed mainly through broken fibers, fiber delamination, fiber pull out and fiber stretching. Calcium carbonate dispersion as a filler in the NR latex compounding also contributed in increasing the ballistic limit of the fabric systems. However, when compared with the unfilled NR latex-coated fabrics, the filler did not show to give any significant differences. As a conclusion, it can be said that the NR latex-coated fabrics were effective in absorbing the impact energy and reducing blunt trauma and has the potential to be used as blunt trauma panel and positioned at the rear of a body armour fabric system.

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