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3D PREFORMING TECHNOLOGIES FOR COMPOSITE APPLICATIONS

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ABSTRACT: With the high end applications like aerospace, the orientation of the fibrous reinforcement is becoming more and more important from load bearing point of view as well as need of placing the reinforcement oriented in the third dimension. In textile process, there is direct control over fiber placements and ease of handling of fibers. Textile technology is of particular importance in the context of improving certain properties of composites like inter-laminar shear and damage tolerance apart from reducing the cost of manufacturing. Depending upon textile preforming method the range of fiber orientation and fiber volume fraction of preform will vary, subsequently affecting matrix infiltration and consolidation. As a route to mass production of textile composites, the production speed, material handling and material design flexibility are major factors responsible for selection of textile reinforcement production. This article reviews the developments occurred in this field of textile preforming along with their advantages and disadvantages and also presents the studies on 3D multilayer interlocked woven reinforced composite materials performance.

Weaving is a process already used extensively within the composite industry, as it is the technique that produces the vast majority of the single-layer, broadcloth fabric used as reinforcement. The poor impact performance, reduced in-plane shear properties and poor de-lamination resistance of such structures has led to use of stitching techniques. In addition to weave crimp, stitching is often considered as a factor, which reduces the mechanical efficiency of reinforcing fibers [1]. With some modifications, the standard industry machines can be used to manufacture flat, multi-layer fabrics in a wide variety of architectures, which have been demonstrated to have highly improved impact performance [2]. Five such 3D multilayered interlocked structures with varying interlacements have been developed; the structures are as represented in the Figure 1 below. Nylon filaments (96Tex) were used for the preform development. Fibre reinforced composites were prepared using these multilayered woven reinforcements with polyester resin by hand lay-up technique.

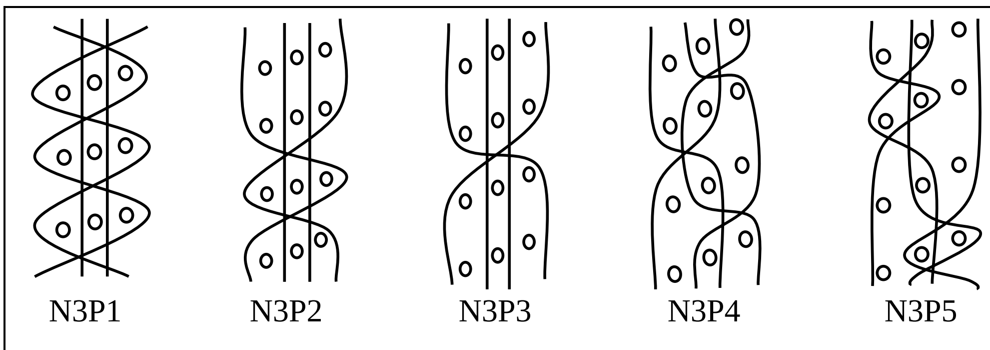

Figure 1. Multilayered Woven Interlocked 3D Structures

The structures of the multilayered woven reinforcements are assessed in terms of Cross-over Firmness Factor (CFF), to represent the influence of interlacements in these preforms. Tensile tests and flexural tests on the composites were conducted on Instron universal testing machine. Low velocity impact drop weight tests were conducted on the prepared composites at three different energy levels viz, 5J, 15J and 25J using a DYNATUP Instrumented Impact Tester.

Results and Discussions:

Impact result show interesting observations with multilayer woven reinforced composites. Figure 2 represents the impact behaviour of these composites to 15J impact. An attempt has been made to understand the influence of multilayer interlacement architecture of the reinforcement on the impact behaviour of composites. As composites with 3D textile preforms can effectively replace conventional materials, it is necessary to develop cost effective ways of producing complicated 3D textile preforms and evaluating their relevant application properties with respect to the complex preform architecture.

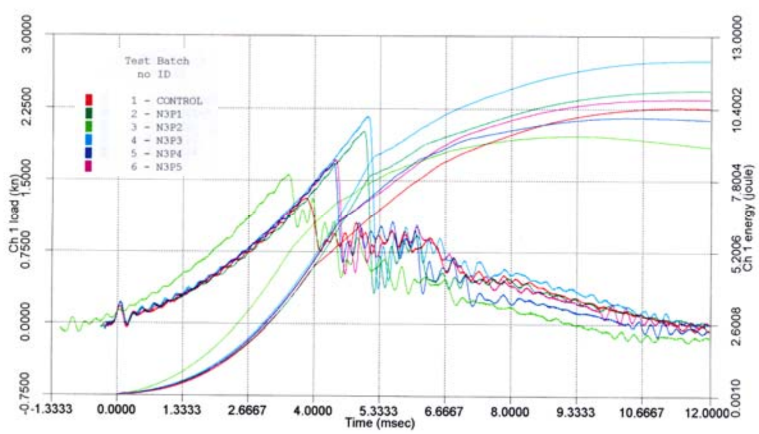

Figure 2. Impact properties of Multilayer reinforced composites

References:

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2. R Alagirusamy, R Fangueiro, V Ogale, Naveen Padaki, *Hybrid Yarns and Textile Performing for Thermoplastic Composites*, Monogram series - Textile Progress Vol 38 (4), The Textile Institute, Woodhead Publishing Ltd, Cambridge, UK, October 2006 (ISBN 1-84569-292-6).