HIGH SPEED DIGITAL IMAGE CORRELATION FOR IMPACT PERFORMANCE OF THERMOPLASTIC AND THERMOSET COMPOSITES

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I. INTRODUCTION

Lightweight materials are of increasing importance in the transportation and energy industries, e.g. automotive, wind turbine, and especially aerospace, where the weight of a structure has a direct influence on operating cost and performance. Composite materials especially thermosets and thermoplastics are prominent materials, instead of conventional materials, such as lightweight metals [1]. When comparing thermoplastic and thermoset composite structures, thermoplastic composites show superiority over thermoset composites on various aspects, such as: better strength-to-weight ratio and higher damage tolerance; eco-friendly manufacturing; the possibility of recycling, remolding and repair with original resin [2].

The main ojective of this study is to investigate the characterization methods for evaluating the high velocity impact performance of thermoplastic and thermoset composites, and identify their failure mechanisms and failure criteria.

II. METHDOLOGY

Carbon fibre reinforced composites (CFRPs) with two different matrices were impacted using a gas gun to understand the effect of the type of matrix on the impact performance of the CFRPs. These impact tests were performed employing gelatine projectiles at a velocity range of 71-75 m s^{-1}. The typical properties of both specimens are shown in Table 1. High speed 3D digital image correlation (DIC) was employed to investigate the out-of-plane displacement and strain maps of the structure during the impact. All test specimens were C-scanned before to gurantee the quality of the samples, and after impact to identify the potential damage areas.

TABLE 1. THE ESSENSTIAL INFORMATION OF CF/PEEK AND CF/EPOXY SAMPLES.

	Specimen A	Specimen B
Resin System	PEEK	Epoxy
Weaving mode of prepreg	Woven	Woven
Number of prepreg plies	7	8
Thickness (mm)	2	2
Density (g cm^{-3})	1.54	1.57
Volume Fraction (%)	50	55

III. RESULTS AND DISCUSSION

The out-of-plane displacement and major strain of all specimens were observed successfully via 3D DIC, impacted by gelatine projectile at the impact velocity of 73 ± 2 m s^{-1}. An example result of out-of-plane displacement is demonstrated in Figure 1. Based on the DIC and C-scan results, it can be concluded that CF/PEEK have more damage tolerance compared to CF/Epoxy under high velocity soft impact (73 ± 2 m s^{-1}).

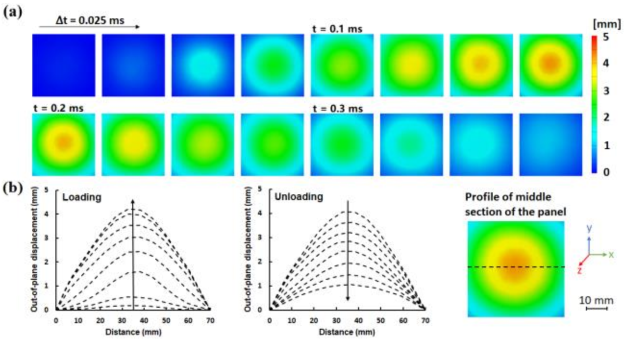

Figure 1. Experimental results of the CF/PEEK panel impacted at a velocity of 75 m s^{-1} for the: (a) out-of-plane displacement maps; (b) out-of-plane displacement profile during loading and unloading phases.

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