BLAST AND OTHER HIGH RATE LOADING TO FAILURE OF COMPOSITE SANDWICH STRUCTURES

J. P. Dear, H. Arora, P. Hooper and I. Palmer

Department of Mechanical Engineering, Imperial College London
Imperial College London
Exhibition Road, London, SW7 2AZ, UK
e-mail: j.dear@imperial.ac.uk

Key words: Composite structures, Modelling, Experimental mechanics

Summary: Presented, in this plenary/keynote lecture, are experimental data relating to composite sandwich materials subjected to different rates of loading including explosive blast. The composite sandwich materials are manufactured using a variety of different skin and core materials. Experimental results are described for quasi-static, high-rate and explosive blast loading using DIC to identify failures processes.

1 INTRODUCTION

An important benefit of composite sandwich materials is their high strength to weight ratio. This has led to their increasing use in marine and aerospace applications. Identifying the damage tolerance of existing and new sandwich constructions is needed in evaluating their retention of mechanical properties after impact or other damage.

2 RESULTS

Figure 1 shows an example of a composite sandwich panel extracted from an offshore wind turbine blade. The redistribution of strain, from the onset of damage e.g. core shear fracture, and its subsequent development is in evidence by DIC and this has been modelled using FEA.

An example, for a marine application, is a composite sandwich material (see Figure 2) subject to explosive air blast (30 kg of explosive (C4) at 8 m). Back face imaging and DIC allowed for deformed contour plots to be made and identification of core cracking and front skin failure during the blast event. Also, these processes have been modelled using FEA.
Figure 2: Air blast (30 kg of C4 explosive at 8 m) of a composite sandwich panel showing high-speed images plus DIC analysis (top); Contour plots at various intervals during the blast for principal strain and out-of-plane displacement linked to an out-of-plane displacement plot across a central horizontal section (bottom-left); Blast event, pressure/deflection trace and damage (bottom-right).

3 CONCLUSIONS

Continuing research studies are addressing structural integrity, blast and other high loading conditions. We thank Dr Yapa Rajapakse of the Office of Naval Research (ONR N00014-08-1-1151), Dr David Hadden of Arup Security Consulting and Professor Andy Morris of E.ON Engineering for supporting Hari Arora, Paul Hooper and Iain Palmer (PhD students).