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An Experimental Study of the Response of Composite Pipes under Impact Loading

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ABSTRACT

Fibre reinforced composites have been attractive for certain industrial applications because of improved stiffness and corrosion resistance. In this study three composites pipes of stacking sequence $[0_2/45_2/90_2/-45_2]_s$, $[45_2/0_2/90_2/-45_2]_s$ and $[90_2/45_2/0_2/-45_2]_s$ were subjected to 6J drop impact testing and the transient response obtained. The $[90_2/45_2/0_2/-45_2]_s$ pipe was noted to have dissipated the highest quantity of energy and also indicated greatest surface ply stiffness. This implied that stacking sequence and damage pattern are very significant in composite design.

KEY WORDS: *composite pipes; dynamic loading and absorbed energy*

INTRODUCTION

The use of composites for underwater applications (eg underwater vehicles, oceanography, subsea installations for oil production etc) and process plant industries is very attractive, both for weight saving, improved stiffness and corrosion resistance. The main loading of such structures under the water is hydrostatic pressure, which increases with immersion depth, but damage tolerance is also a key parameter. Impact damage may occur either during handling or in service with marine obstacles. Hence, improved understanding of resistance to impact is pertinent to improving the long-term integrity of composite structures under hydrostatic pressure and impact. In addition, composites pipes are used extensively in the chemical process industry.

It is important for the success and competitiveness of both the marine and chemical process industries that safety, stiffness and strength be the central issues as the technology grows. The high specific strength and stiffness of CFRP materials has made the attractive. However, composites such as this are inherently brittle and may exhibit a linear elastic response to failure with almost no plasticity. Among the challenges which composites present is the complexity of their mechanical behaviour particularly when loading is such as to produce damage or failure.

The impact behaviour of composite pipes has received much less attention than flat panels (see the excellent review by Abrate [1994 & 1998]. Kistler and Waas [1998] have compared strains measured on carbon/epoxy cylinders with the results from model predictions and Gning et al [2005 a & b] reported that low energy impact on composite cylinders result in a drop in implosion pressure resistance. This was associated to the appearance of intralaminar cracks rather than delaminations.

Hull [1991] observed that glass and carbon fibre reinforced thermoset tubes progressively crush in fragmentation and splaying modes as illustrated below [*Fig 1*].

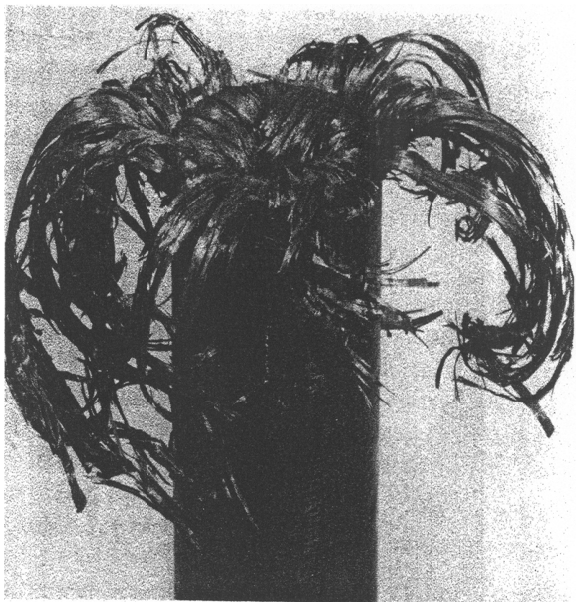

Fig 1 Splaying of carbon fibre reinforced tube [6]