An Experimental Study On Repetitive Slamming Wave Impact On Deformable Composite Structures

D. van Nuffel, *I. De Baere, W. Van Paepegem, J. Degrieck*
Ghent University, Department of Materials Science & Engineering,
Sint-Pietersnieuwstraat 41, 9000 Ghent, Belgium
Diederik.VanNuffel@Ugent.be

Fibre-reinforced polymers (FRP) are applied more and more in marine constructions, e.g. sailing yachts, catamarans and high speed crafts. The use of FRP involves important advantages in comparison with more convenient materials (e.g. steel) in marine applications. Corrosion resistance, limited maintenance, a long life time, low weight and sometimes a lower cost are the main motivations for ship constructors to use FRP.
Untill a few decades ago, marine composite structures were designed very stiff and quasi rigid, to resist the slamming wave impact. Slamming wave impact, seen as the most important load that marine structures encounter, is characterized by high local peak pressures (up till 10 bar and more) with a very short duration (typically millisconds). Figure 1 shows the water slamming on a speed boat. Nowadays, due to the continuous striving for less material and less weight, the structures have evolved to thin-walled and deformable components. At one hand, this deformability leads to a reduction of the peak pressure during water impact which is basically a good thing. But at the other hand, fatigue damage (e.g. delamination) and final failure can be induced in the composite structure due to repetitive deformation as the structure encouters repetitive wave impact.

Figure 1: *Speed boat slamming on the water surface.*

Figure 2: *Experimental test facility.*

In this research, an experimental test facility has been built to investigate the influence of the deformability of the composite structure on impact pressure and damage growth. Automation of this test facility makes it possible to perform repetetive tests without manual intervention, and to control the impact velocity. The facility consists of a stepladder which is fixed at one end to a rotating shaft which, on its turn, is connected to an electric motor. A controlling unit regulates the motor and ladder motions. At the other end of the stepladder, a test object is attached which is forced into a water bassin as the ladder turns downwards. Figure 2 shows a picture of the test facility.

To create an initial idea about the influence of the deformability of the composite structure on impact pressures, tests with a full rigid cylinder and a hollow deformable cylinder have been performed and compared. In both cases the pressure signals showed a very high and short pressure peak. In contradiction with the prospections, the average peak pressure measured for the deformable cylinder was comparable to the the peak pressure measured for the rigid cylinder (5.17 bar versus 5.35 bar). However, conclusions can not be made since there is too much scatter on the results (standard deviation: 2.31 bar versus 1.51 bar). Too low sampling rate of the data acquisition system (51 kHz) might be the cause for this scatter. New results with higher sampling rate have to be carried out to draw conclusions from the slamming tests.