Scale testing of a partially confined blast chamber

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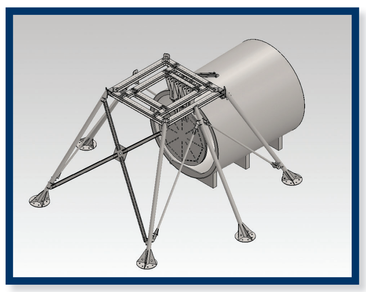
INTRODUCTION AND BACKGROUND

Blast-enhanced research is one of the many fields investigated and studied by the CSIR's Landward Sciences group for almost 50 years. In 2008 Landward Sciences came into possession of a decommissioned submarine section from the Emily Hobhouse. The hull segment was converted into a diagnostic tool by restraining it to a concrete base with one end of the chamber sealed off by means of a reinforced concrete wall. Explosive charges were detonated in the middle of the newly obtained blast chamber, Emily, to investigate pressure behaviour within semi-confined spaces. Additional confinement of the open side of the blast chamber became necessary to identify further increases in pressure readings. A scale model of the blast chamber, Emily, was constructed with the addition of a pendulum plate hanging concentrically covering 65% of the open area.

PURPOSE OF SCALED BLAST CHAMBER

The purpose of this particular test is to evaluate and identify the behaviour of pressure in a semi-confined space, after which it has been partially confined by making use of a ballistic pendulum. The approach will be to conduct tests on a smaller scale to reduce risks and monitor the pendulum frame's ability to function properly. Should the test produce valuable results, the scaling will be done to test on Emily.



SIMULATION AND MODELLING OF THE SCALE MODEL

During the concept design of the scale model, Semily, the calculations of the blast of a 24 g Comp B charge were conducted to determine how the blast chamber would respond when the open side of the sub is confined up to 65%. The charge is detonated in the middle of the blast chamber and displays the pressure evolving inside the confined area as well as when 30 ms is reached, the pressure moves back and forth several times before venting through the gap as illustrated in the figure. The peak pressures that were obtained from this particular simulation is that of 403 kPa for side-on pressures and 727 kPa for face-on pressures.

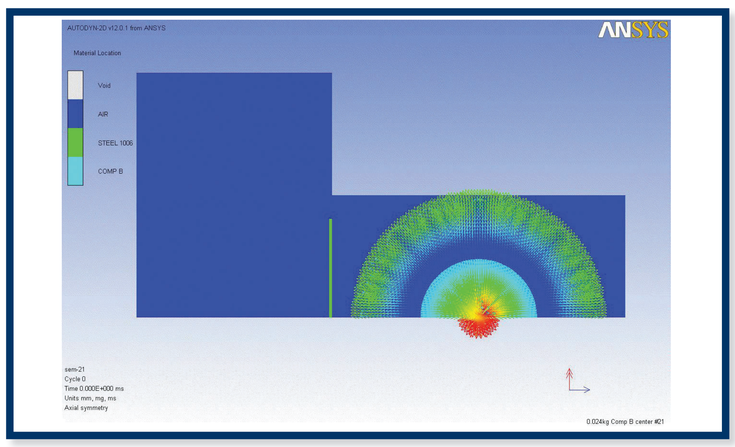


Figure 1

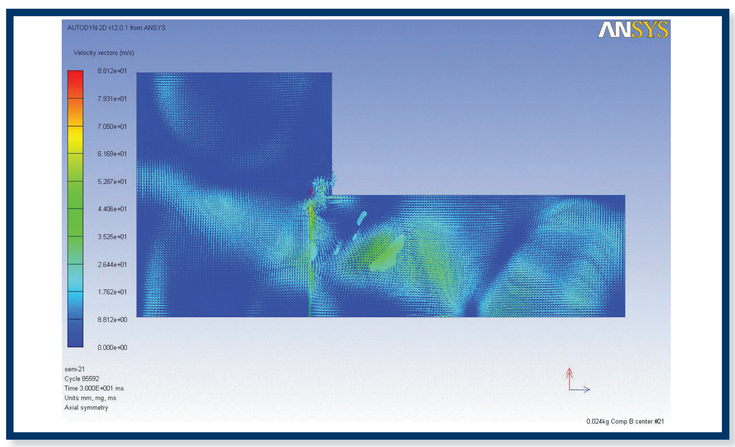


Figure 2

TEST SETUP AND EQUIPMENT

A series of tests using cylindrical Composition B explosive charges of 24 g (length/diameter = 1) each were carried out in the 5:1 scale model of the blast chamber, Emily, at the CSIR test range DBEL. Three charges were detonated without the pendulum plate in position to compare the pressure readings retrieved from the full size blast chamber, Emily. Three further charges were detonated with the pendulum plate in position. To ensure that the setup of the test is done correctly, the appropriate sensors should be used to capture the applicable data during the detonation of the charge. The following sensors were used in measuring the test data: Side-on PCB137 probes, Face-on Kulite 375M sensors and one momentum gauge that fits into the wall of Semily. High speed footage at 2 000 frames per second was taken by two IPX high speed cameras to observe pendulum plate motion during detonation.

RESULTS (NON-CONFINEMENT)

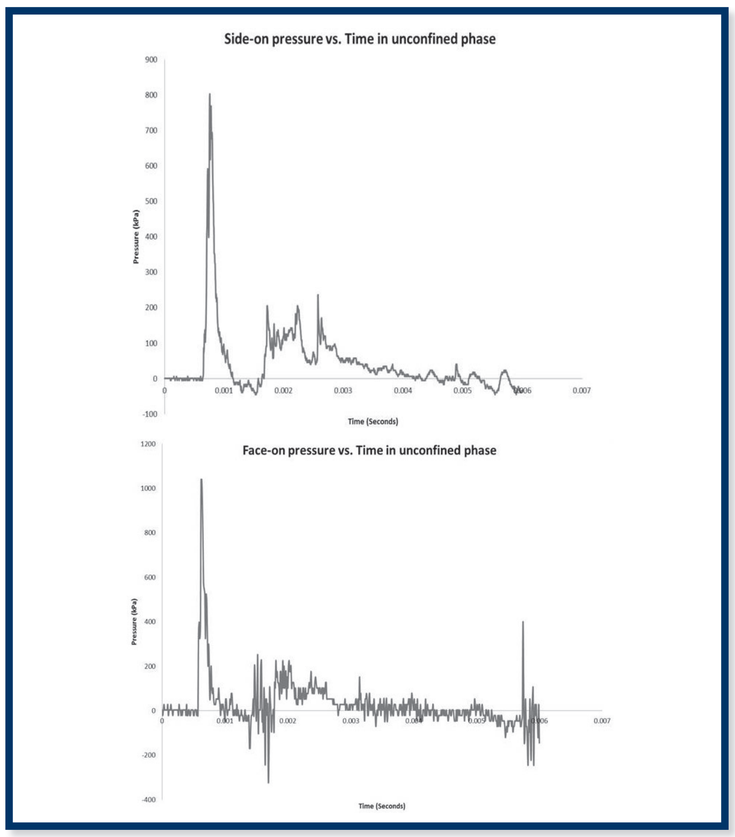


Figure 3

RESULTS (CONFINEMENT)

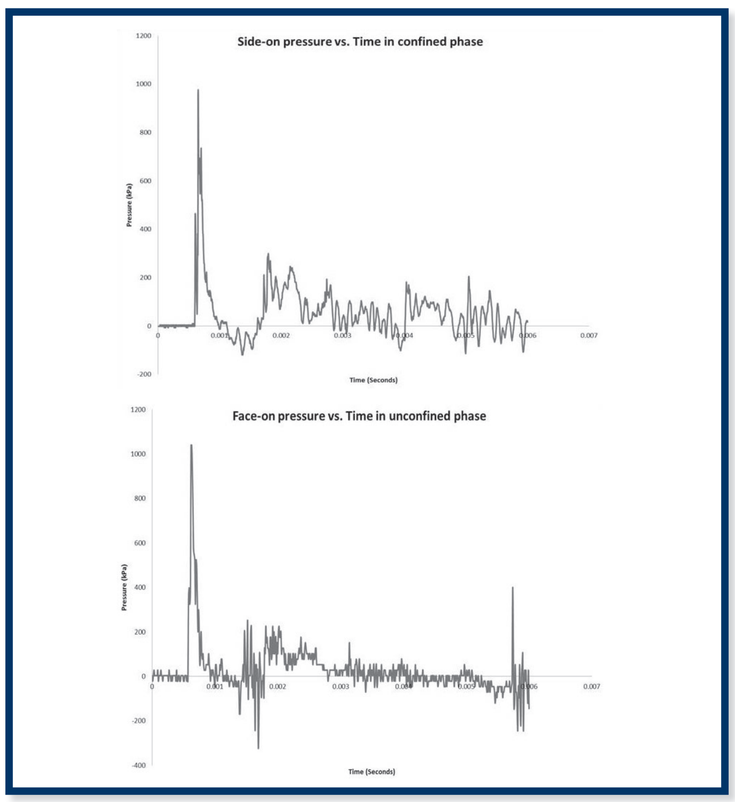


Figure 4

A scale model of the blast chamber, Emily, was constructed with the addition of a pendulum plate hanging concentrically, covering 65% of the open area.

DISCUSSION AND NEXT PHASE

Illustrated in **Figure 3** and **4** are the results obtained during testing of the scaled blast chamber. In both cases the pressure dissipates over time, showing pulsating behaviour as the shockwaves reflect off the chamber walls. By looking at the peak pressure readings from the confined and unconfined graphs, it is clear that in both cases the pressure has increased by partially confining the open side by 65%. Face-on pressure increased from 1 MPa up to 1.7 Mpa, while side-on pressure readings increased from 0.8 MPa to 0.95 MPa in the confined state.

It is recommended that more tests are done within the scaled blast chamber to retrieve repeatability in measurement results. Up-scaling of the pendulum to cover the full-size blast chamber will commence by means of structure calculations and detail designs. The design of the scaled blast chamber provided valuable information in the field of blast enhanced research, and will contribute to the future success of the up-scaling of the blast pendulum.

REFERENCES

Mostert, F.J. Commissioning of 'Emily' (Blast Chamber at DBEL) and follow-up tests with RDM compositions in this test facility, CSIR report GLBL-0BSY2-10-005 Rev 1, January 2011.

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SolidWorks CAD Software programme.

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