

# **BLAST EFFECTS ON MULTI LAYERED PROTECTIVE WINDOWS**

Maj. Z. Savir<sup>1</sup>, Cap. O. Abada<sup>1</sup>, Academic Officer A. Schenker<sup>1</sup> and A. Brill<sup>2</sup>

<sup>1</sup> *Corps of Combat Engineers – Fortifications & Current Security Branch, Israel*

<sup>2</sup> *RAFAEL Ballistics Center, P.O. Box, 2250 Haifa, 31021, Israel*

The research effort presented details the structural behavior of multi-layered laminated glass windows to dynamic loads. The research consists of two phases. In the first phase, full-scale blast tests were performed on different types of windows. The blast tests included the initiation of large explosive charges at different stand-offs from the protective windows having a thickness of 42 mm and 62 mm and consisting 5 and 7 layers respectively.

During the second phase, calibration and validation of a FE model using LS-Dyna was performed with the ability to solve and predict the structural effects of blast on laminated glazing. The experiments were held in the Negev (Southern Israel) during five tests in which data was compiled including displacements and strains. This data was then used for the calibration and validation of the numerical code.

The purpose of the research was to develop an empirical and numerical tool for predicting the damage levels for multi-layered protective windows.

The present research was conducted by the IDF Directive Committee of Structural Protection R&D, the Corps of Combat Engineers – Fortifications & Current Security Branch and the Rafael Ballistics Center.