

## EXPERIMENTAL TEST SETUP FOR THE DEVELOPMENT OF PROTECTIVE COMPOSITES

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Over the last three years TNO has explored the possibilities of fiber-reinforced composites to provide vehicle underbelly protection against blast loading. This work consists of three parts:

- Numerical analysis of full-scale blast loading conditions in comparison to scaled blast loading conditions.
- The development of a test method suitable to easily perform multiple test series for the development of fiber-reinforced material composition;
- The actual development of a fiber-reinforced material for blast protection.

The first item has already been presented in a previous MABS conference. Here, the development progress of the test method is further discussed.

Full-scale experiments are performed by TNO as a standard by using the so-called NL reaction frame. With this setup, the response of flat-panel materials to typical underbelly blast loading conditions (i.e. STANAG 4569 levels 2-4) can be evaluated. The material response is captured by two high-speed cameras inside the reaction frame, and their stereo images can be used to determine the out-of-plane deformation field and in-plane material strains during the deformation process. However, significant effort is required to undertake these full-scale tests, which has led to the search of a more efficient way to evaluate the performance of composite materials against blast loading. A faster approach is found in quarter-scaled tests. By downscaling, multiple tests can be performed on a single day, allowing for faster evaluation of many material parameters, using limited specimen size (length, width and thickness) fiber-reinforced composite material samples.

Downscaling requires comparison between full-scale and scaled tests to validate the scaling rules. This paper describes the comparison of full-scale and scaled STANAG 4569 level 2 steel pot tests on ARMOX 440. It shows that the developed scaled tests method is well suited to rank material options on their characteristic failure mechanism. The advantages and disadvantages of the scaled test approach are shown and discussed.