Defence-related Research Action - DEFRA

ACRONYM: BlasTex

Title: Blast and fragment resistant Textile

Duration of the project: 01/05/2024 - 30/04/2028

Key words: PPE, Vest, Explosion, Blast, Fragments

Budget: 1.086.000 €

of which RHID contribution: 894.000€

PROJECT DESCRIPTION

This project aims to develop a paradigm shift in explosion-proof textiles. It will optimize a unique test setup for combined blast and fragment impact, select and test materials from SIOEN's range, and use the best performers to design a new composition with increased explosion protection.

General objectives

- **Objective 1**: Further develop the existing test setup for determining a material's blast protection level using combined blast wave loading and fragment impact.
- **Objective 2**: Determine the V50 for a selection of four textile-based solutions in SIOEN's range, according to the STANAG 2920.
- **Objective 3**: Testing the highest performing textiles with the combined blast and fragment impact method. The results will be compared with the current STANAG standards.
- **Objective 4**: Develop a validated numerical model for modelling textile-based protection materials under combined fragment impact and blast loading.
- **Objective 5**: Design, simulate, and test an improved fabric aiming for a 10% increased V50 under combined fragment impact & blast loading compared to current solutions.
- **Objective 6**: Proposing a new standard for more accurate/detailed assessments against the combined blast/fragment loads. Contact the NATO Standardization Office (NSO) for formalities.

Methodology

A. Experimental Evaluation:

1. **Fine-tuning the testing setup**: This involves evaluating and selecting various parameters and variables such as sample size, clamping, fragment impact position, size, material and shape, blast pressure amplitude, time interval between fragment impact and blast wave etc.

2. **Material identification and selection**: Up to six suitable textiles with specific fiber types and yarn-architecture, commercially available and used in ballistic and blast protection solutions will be selected. The focus will be on plain weave textiles composed of Para-Aramid and UHMWPE fibers.
3. **Conventional impact testing**: The selected materials will be tested under fragment impact only to evaluate their performance.
4. **Combined fragment impact and blast testing**: The best performing materials will undergo combined fragment impact and blast testing. The V50 will be determined based on chosen blast pressure intensities.

B. Development of Finite Element Models:

1. **Developing Finite Element Models**: These models will be in accordance with the experimental results. They will also transfer the material behaviour into calculation efficient equivalent models.
2. **Generating finite element models for different textile constructions**: Choices will be made on the use of shell/solid elements, or a hybrid modelling technique for a performant simulation of the textile behaviour. Correct modelling of boundary conditions, geometry and speed of fragments, and pressure of the blast wave is also crucial.
3. **Performing simulations for different configurations and combinations**: Simulations will be performed for different configurations of textile constructions and for different combinations of blast pressure and fragment velocity. The results will be compared with experimental measurements. The confidence level of the simulations will be assessed and the possibilities to use it as a future design tool will be critically investigated.

C. Textile optimization and proof-of-concept evaluation:

1. **Design and Development**: A textile optimised for certain blast/fragment load levels is developed. This requires a complete understanding of the blast and ballistic process for reliable design and development of an improved ballistic material.
2. **Material Selection**: The selection of components for the composition of the optimized blast protection composite is based on variables such as:
    - Fiber type
    - Yarn properties: weave type, pattern, areal density
    - Effects of fabric finishing
    - Number of plies
3. **Testing**: The newly developed textile is then tested for its effectiveness in withstanding certain blast/fragment load levels.

Potential impact of the research on Defence

The project aims to improve the army's explosion protection through a novel testing approach combining blast loading and fragment impact. This approach, along with numerical modelling, will lead to better, lighter explosion protection for military personnel, platforms, and infrastructure. The project will also enhance the understanding of how textile architecture can mitigate the effects of blast and fragment impacts. The ultimate goal is to improve platform resistance and resilience, increase mission success probability, and enhance personnel protection, potentially extending to compound infrastructure protection.

Description of the expected final research results (model, scenario, report, workshop, publications, etc.) and valorisation perspectives at short and medium term.

Expected outcomes:

- Thorough understanding of textile material response under the combined effects of blast and fragments.
- Step-by-step decision making on the hierarchical structure of an optimized textile lay-up, from fiber type to yarn size to woven architecture to layer positioning.
- Further development of Finite Element Analysis capabilities around textile mechanical behaviour.
- Understanding the influence of further textile processing and its trade-off characteristics: ballistic resistance vs wearing resistance.
- Assessment on the influence of curved processed textiles on the ballistic resistance: from a flat textile to a curved application specific textile.

CONTACT INFORMATION

Coordinator
Kristof Daels
Sioen NV
e-mail: Kristof.daels@sioen.com

Partners
Wim Van Paepegem
Ghent University / Department of Materials, Textiles and Chemical Engineering
e-mail: wim.vanpaepegem@ugent.be

David Lecompte
Royal Military Academy / Department of Structural & Blast Engineering
e-mail: david.lecompte@mil.be

LINK(S)

/