Summary of Phd thesis

BACKGROUND OF THE RESEARCH

Modern information societies are highly dependant on infrastructures. Realizing this dependency and the increasing terror threat, new dimensions of safety evolved, like health safety, environmental safety or informational safety. Several recent military affairs showed, that the infrastructure affected by armed conflicts does influence life of the society. Thus, protection of critical infrastructure is increasingly considered by defense management. Protection of infrastructure can not only be linked with blast mitigation, but – depending on future measures – may include it as a must.

The following scientific problems serve as basis for the research:

- In risk assessment, risk is calculated as the product of probability of failure and consequence. Due to simplicity, lack of detailed input information and the difficulties of describing loss of human life as a consequence, a qualitative method is used in risk assessment. These methods (used by UFC 4-020-01 [2] and JFOB Force Protection Handbook [134]) provide a subjective classification of the assets, based on a fictive scale. This is adequate for comparison between assets, but engineering design requires using an absolute scale. A quantitative method could be used to judge structures and situations based on a well-accepted reliability, regardless of the relations to each other.
- Currently, VBIED charge mass tables are determined using one of these methods:
    - analyzing seized VBIED-s by officials (classified information)
    - post-disaster investigations, e.g. by measuring crater (may be inaccurate)
    - assuming maximum charge weight based on cargo volume (may be excessive)

  With the use of a realistic *W* series, design methods could be improved, but this requires a new approach in investigations.
- Though CFD analysis and simulation of blast waves are well-accepted techniques, there are still many problems to be investigated. One such problem is the cumulative effect of VBIED charges.
- In infrastructure protection, or other defense related design problems, a calculation method considering stochastic load effects is necessary. This method shall give objective reliability as result. Capable methods are used in other engineering fields, so linking them with blast resistant design is to be considered.

AIMS

I restrict the research to a certain infrastructure type, and to a certain threat type. The dissertation focuses on defense infrastructure (considering a military compound), and a typical attack type against these compounds, the SVBIED bombings.

- Through analyzing the SVBIED perpetrators propaganda videos, I gather valuable information for engineering design,
- I make an assumption for the design value of charge weight,
- I check which dynamic design method can be linked with classical reliability methods,
- I check the statistical parameters of effects and resistance in case of blast loading,
- I validate classic formulas of blast wave parameters using results of self-recorded blast experiment data,

- I carry out CFD calculation on blast wave propagation in complex geometry and I check the effect of VBIED charge shape using this method,
- I present a quantitative design methodology for SVBIED attacks,
- I write Mathcad programs for all the different methods considered.

THESES

1. With studying the propaganda videos of the perpetrators, I presented a new way of investigating SVBIED attacks. The method proved to be useful in determining the *W* charge weight.
2. I carried out blast experiments using high-frequency pressure sensors. Based on the experiment data, I presented the pressure and impulse curves of RDX and ANDO-EV explosives.
3. I carried out CFD simulations of blast waves with complex geometry. It was shown, that the cumulative effect of a VBIED charge is negligible.
4. I created Mathcad programs solving blast loading on simple structural members using the most acknowledged design methods. I analyzed the coupling of different dynamic and reliability models. Coupling the regressive *P-I* diagrams with Monte Carlo simulation resulted in a fast-running, generally valid design method.
5. I adapted a special design method – usually used for accidental situations – for blast loading. The method can produce the reliability of the structure in a quantitative way.