PROBABILISTIC FAILURE MODEL FOR STRUCTURAL COMPONENTS SUBJECT TO AIR-BLAST LOADS

S. Marjanishvili, PhD, PE, SE, T. Tadepalli, PhD

Hinman Consulting Engineers, Inc.
One Bush Street, Suite 510, San Francisco, CA 94104, USA
shalva@hce.com (415) 621-4423

ABSTRACT

Current design practice mandates that structural elements vulnerable to explosive threats are to be designed to resist the air-blast pressure time history generated by explosion. In this scenario structural resistance as well as weapon size and location are predetermined. However, due to the violent and almost random nature of the explosion as well as the uncertainties in explosive type and location; and to achieve an economical structural design, it is desirable to include variability in the analysis. It is intuitive that structural response will change if the threat (charge size or standoff or both) changes. In this paper we have developed procedures using probabilistic analysis techniques to estimate probabilities of failure with regard to the safety of structural elements subject to air-blast loads. Derivation of probability density functions (PDF) of the dynamic resistance and threat, needed to calculate probability of failure, is presented. We have developed example with extensive graphical visualization to demonstrate step-by-step process of calculating probability of failure

Two main objectives of this study are to derive a simple procedure for probabilistic air-blast analysis of structural components and demonstrate usage of concepts *probability of failure* and *risk of failure* in practical application. Risk of failure is the concept that can be universally understood my facility stakeholders as well as design engineers, since the risk of failure is a product of a probability of failure and the cost given failure. Furthermore the probability of failure concept can be used to uniformly apply risk of failure (cost of failure) across structural components which are subject to variable threat scenarios. i.e., risk of failure or probability of failure determines design performance criteria.

Approach presented in this paper, provides mathematical procedure to transition from concept of *Risk of Failure* (as a cost defined by a building owner) directly into design performance criteria, which is used by engineers for structural design. Since risk can be applied universally and uniformly over the entire structure, we have developed theoretical approach to design criteria to match acceptable losses by building stakeholders.

Comparative analysis performed to determine the effects of uncertainties in threat size and locations indicate that design performance criteria based on a building type and level of protection only, will result in design with a range of probabilities of failure. Therefore we conclude that the risk of failure and probability of failure concepts should be used to determine design performance criteria to achieve desired structural performance.