

## Simulating Tornado Missile Impact on RC structures

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In recent years, many experimental studies have been conducted to study the penetration and perforation of missile impact on reinforced concrete (RC) slabs. These experimental studies have been used to develop empirical formulas for evaluating the penetration depths and the minimum thickness required to prevent perforation. The empirical formulas provide a means of reasonable and easy assessment. However, actual conditions in the assessment of an impact behavior in real structure often varies significantly from those used in the experimental studies. Some of these relate to the type of concrete, reinforcement ratio, boundary conditions, presence of additional structural members such as supporting beams, type of missile/impacting object, velocity of impact, etc. Some experimental studies have also been used to develop and calibrate finite element models. Modeling the impact behavior in reinforced concrete slabs using sophisticated finite element studies has gained wider attention only in the past decade or so, as the advanced models for modeling the material behavior and conducting large deformation nonlinear analysis have become readily available. Even with the most advanced analysis and modeling tools, the problem of evaluating penetration and perforations in reinforced concrete structures is highly sensitive and sometimes unstable. Therefore, it is extremely important that the models used for such analyses be first calibrated using the data from experimental studies. In this research, we propose a novel approach for modeling the behavior of reinforced concrete slabs subjected to missile impact. First, we use data from one experimental study to develop and calibrate various models needed to conduct the finite element analysis. Then, the calibrated models are used to conduct

a blind predictive analysis for a different experimental setup. It is shown that comparison of the experiment and the analytical results for the blind test provides confidence in the predictive capability of the simulation approach with calibrated parameters.