P45 Apex: A Novel Approach for Predicting Two-Way Steel Plate Response

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Abstract:

Models for determining two-way plate response under blast loading have many applications within the military and government, including determining vehicle vulnerability and weapon lethality. However, many of the existing fast-running models are highly idealized and do not represent the physics of plate response very accurately. High fidelity models, on the other hand, require much more computational time and effort and also require a certain level of expertise on the part of the analyst.

Apex is an entirely new and modern tool for predicting two-way steel plate response under blast loading. The goal was to create a model with the accuracy of a non-linear finite element analysis (FEA) and the computational speed of a single-degree-of-freedom (SDOF) analysis. This was achieved by running a suite of 576 finite element calculations within a parameter space defined by five independent variables (thickness, aspect ratio, short span, boundary conditions, and yield strength). From each calculation, key SDOF parameters, such as the resistance function of the plates and the transformation factor, were extracted and parameterized. Least-squares multi-dimensional fits were applied to these parameters in terms of the plate dimensions, strengths, and boundary conditions. The Apex model is implemented into an enhanced SDOF solver that employs adaptive time stepping and error control techniques to minimize run time and increase accuracy. The model produces a history of response from which the peak value may be extracted and compared to established damage criteria.

The methods utilized in the development of Apex can easily be used to expand the current parameter space of the model or be used to develop new fast-running models for a wide range of applications. They may also be applied to a wide range of structural systems beyond two-way steel plates.

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