

ABSTRACT

This thesis presents the development of an artificial neural network (ANN) to predict the performance of steel-plate composite (SC) walls subjected to projectile impacts. SC walls are a composite structural system comprised on two steel external steel plates with a concrete core infill. This configuration leverages the high compressive strength of concrete with the ductility and confinement of steel plates to provide efficient protection to blast loading for protective structures. SC systems are an efficient and robust alternative to the reinforcement concrete (RC) systems currently used for protective design due to their modularity and highly ductile behavior prior to failure. A sub-component of blast-design is the generation of shrapnel created during a blast event. Shrapnel or deliberate projectiles can impact an SC structure and potentially compromise the structure or perforate into an object behind the barrier. Recent studies have been conducted into the design of SC walls for impact loading to include finite element modeling; however, the design equations that exist from this research are overly conservative and limited in scope based on empirical derivation. The degree of conservatism for this design method increases significantly when the equations are applied outside the calibration data, creating a significant need to further evaluate the impact response of SC walls to a broader set of data and evaluate more parameters that may affect design requirements. This study uses finite element modeling to employ a computational approach to evaluate SC impacts without the limitations set by the existing design equations. The models were generated in LSDYNA and benchmarked to existing experimental data presented in Kim (2018). The benchmarked models were then applied to a much larger scope of parameters to create a database of a wide range of SC walls and projectiles. The resulting database was used to train a supervised ANN to predict key outcomes for SC impacts such as result, damage mode, penetration depth, and residual velocity based on provided SC wall parameters and projectile parameters. The ANN demonstrates strong predictive capability and provides an efficient alternative for evaluating SC wall impact resistance.