DESIGN OF BLAST RESISTANT STEEL PLATE COMPOSITE SYSTEMS (SC): ESTABLISHING A UFC EQUIVALENCY FRAMEWORK

Steel-plate composite (SC) structures are gaining prominence in blast-resistant design due to their superior strength, ductility, and rapid construction benefits compared to similar traditionally used reinforced concrete (RC) systems. However, existing blast design standards such as Unified Facilities Criteria (UFC) 3-340-02 lack provisions for SC construction. This gap poses challenges for the construction of SC structures in Department of Defense and Department of Energy facilities, both of which require the use of the UFC.

This thesis establishes an equivalency framework between UFC 3-340-02 and AISC N690-25, aligning SC design with established RC and steel provisions in the UFC through a side-by-side evaluation of the standards. Commentary and modifications between the two standards are introduced where necessary, culminating in a proposed UFC-equivalent chapter formatted for practical use in design. Additional design guidance on SC-to-SC and SC-to-RC connections is also provided.

To validate the proposed equivalency, three methodologies for determining SC element response under dynamic loads are explored. Chapter 8 presents a worked example of hand calculations based on the developed equivalency guide. Chapter 9 introduces a direct numerical solution to the equation of motion. Chapter 10 develops a finite element analysis model for simulating SC slabs under blast loads, while Chapter 11 runs a comparative analysis of the three approaches against each other. All three methods were found to give reasonable estimates of SC slab midspan deflection, with general agreement within 10% found between all methods tested.

The research demonstrates that SC structures can be effectively designed within the UFC framework in an alternate but equivalent way – maintaining the safety and performance standards mandated for high-risk environments. By removing the need for SC structures to go through a case-by-case exemption process, this work establishes a foundation for broader SC adoption in high-security DoD and DOE infrastructure.