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DESIGN OF BLAST RESISTANT STEEL-PLATE COMPOSITE (SC) L-JOINT CONNECTIONS

The design of blast-resistant structures is critical for defense related facilities and industries. An emerging option for these applications is Steel-plate composite (SC) systems. SC systems include a steel module and concrete infill. Steel modules can include but are not limited to steel faceplates, tie bars, tie plates, diaphragm plates, and steel headed stud anchors. SC technologies have been adopted as a structural system in the design of nuclear powerplant containment vessels and high-rise buildings. These applications have benefitted from the inherent ductility and modular construction that SC systems provide.

When designing structures to resist blast and impact, the desired behavior is for the structure to demonstrate ductility. Previous research has explored the behavior of a variety of SC elements; however, limited research on the behavior of L-joint connections exists. For L-joint connections to demonstrate ductile behavior, it is suggested that the joint that connects SC components- SC beams, columns, or slabs- be stronger than the connected elements. L-joint connections with joints stronger than the connected SC elements are considered full strength connections. As such, the connected elements reach their maximum bending moments and demonstrate ductile behavior. This study proposes a design philosophy for achieving full-strength L-joint connections using a diagonal steel reinforcing plate in the joint. This study evaluated the behavior of L-joint connections with joint reinforcement through large-scale experimental testing and subsequent benchmarked finite element analyses. The inclusion of a diagonal plate contributes to the L-joint connections ability to resist joint failure and develop a greater moment capacity in the SC members. This finding was also validated through finite element analyses comparing specimen behavior with and without the joint reinforcement. The specimen without joint reinforcement experienced joint shear failure in the concrete while the experimental specimens were able to demonstrate ductile behavior prior to failure.