

Blast Resistance of FRP Retrofitted Un-Reinforced Masonry (URM) Walls with and without Arching Action

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Abstract:

The increased amount of terrorist activities directed against worldwide facilities led to an evaluation of the survivability of masonry structures to blast loadings. Un-reinforced masonry (URM) walls have a low resistance against out-of-plane blast loading due to their low flexural capacity and their brittle mode of failure. Failures of URM walls were identified by The Masonry Society (TMS) and the Federal Emergency Management Agency (FEMA) as one of the major causes of material damage and loss of human life due to blast loads. This proved an urgent need in developing effective retrofitting techniques in lieu of more elaborate conventional approaches to upgrade masonry members to resist blast loads. One alternative method is the use of Fiber Reinforced Polymer (FRP) composites on the surfaces of the walls to resist high flexural stresses and maintain the integrity of the walls/systems. However, this is a new approach to blast resistant design and there is little available test data to use as a basis for the design of wall upgrades.

Two series of walls, reflecting eight un-grouted URM walls with different slenderness ratios and different strengthening schemes using FRP composite materials were tested in this study by varying blast charge weights and standoff distances. FRP composites in the form of rods and laminates were used as strengthening materials. The walls were supported from the top and bottom without side wall-to-frame connections and subjected to blast loads at their mid-height. The tests caused a well-distributed range of damage levels; from no damage to complete failure. Tests revealed that the shear capacity controlled the blast behavior of the strengthened walls. Furthermore, the analytical analysis showed that a single degree of freedom (SDOF) approach could be used to predict the behavior of masonry walls strengthened with FRP. The wall behavior could subsequently be correlated to threat and damage levels defined by the Department of Defense (DOD) Standards.

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