Response and Analyses of Multi-wythe Insulated Masonry Walls to Out-of-Plane Dynamic Pressure

ABSTRACT

This paper presents analyses and experimental results pertaining to out-of-plane dynamic loading of multi-wythe insulated masonry walls. The objective of this project was to identify the resistance mechanisms of multi-wythe insulated masonry walls subjected to blast loads and to define an adequate resistance function for design use. Specific emphasis was targeted toward identifying the potential use of foam insulation as a blast resistance mechanism. The National Concrete Masonry Association (NCMA) recommended four typical wall sections often found in masonry construction. Of the four sections, two were chosen for full-scale testing: a conventional block wall with a brick veneer and an identical section except that A-blocks were used in place of conventional CMU's. Based on fundamental mechanics, the capacities of these two sections are identical. A control wall was also included that was made up of only fully-grouted concrete masonry units (CMU's) and was designed so that the flexural strength, as well as the mass, was equivalent to that of the two veneer sections. Full-scale dynamic testing of the wall sections was conducted by the Force Protection Branch of the Air Force Research Laboratory (AFRL) at Tyndall Air Force Base Florida. Differences in the peak deflections were noted between the A-block and conventional walls; differences in the peak pressures and impulses across the reflecting surface were also noted. The post-test forensics indicated that the foam insulation did not contact the brick veneer; thus, it did not add to the resistance of the system. Analyses confirmed that the metal ties between the CMU's and the brick veneer were capable of transmitting the peak reflected pressures. The analysis of the wall sections made use of single-degree-of-freedom (SDOF), multi-degree-of-freedom (MDOF), and nonlinear finite element (FE) models. FE modeling showed that foam is capable of increasing the dynamic resistance of a system by spreading out the transmitted impulse so that the peak pressure is reduced. Issues concerning the ability of the foam to become active in the resistance mechanism will be discussed and recommendations for further study will be presented.

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