RECENT ERDC DEVELOPMENTS IN COMPUTATIONALLY MODELING CONCRETE UNDER HIGH RATE EVENTS

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Personnel of the US Army Engineer Research and Development Center (ERDC) have been performing a considerable amount of work in enhancing and developing numerical methods and constitutive models for simulating standard strength and higher strength fiber reinforced concrete. Methods currently under investigation include one based upon the Reproducing Kernel Particle Method (RKPM) and another using the Lattice Discrete Particle Method (LDPM). Developments in constitutive models include the generation of the Advanced Fundamental Concrete (AFC) model, based on improving the Holmquist-Johnson-Cook (HJC) model, and the adaptation of the Microplane Model to include the effects of fibers.

A set of experiments was performed where a fragment simulating projectile (FSP) penetrated several thicknesses of a fiber reinforced concrete (FRC) panel. Several of the methods and material models were used to simulate these tests, concentrating on various ways to model the FRC. The HJC model, the AFC model, and the Mat_Concrete_Damage model from LSDYNA were all inserted into a standard continuum finite element grid simulation. Also used was the Lattice Discrete Particle Method in several forms, including one that homogenized the effects of the fibers into the constitutive model and one that explicitly modeled the fibers and discretely inserted their contribution into the vector constitutive equations only at specific locations where a fiber existed. Extensive characterization data has been developed for the FRC material examined in this study in the form of stress and strain path tests, fiber pullout experiments, and third point bending tests. Model parameters were generated against this data and then used for the high rate penetration simulations. Under investigation was how well these methods replicate the various possible mechanics found in the problem, including projectile penetration and crater formation to complete perforation with a high residual velocity of the penetrator. Comparisons will be presented between the different methods and models and commentary given on each.

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