MODELING BLAST RESPONSE OF ADVANCED CONCRETE MATERIALS WITH SECOND-ORDER HEXAHEDRAL ELEMENTS*

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Explosive detonations applied to reinforced wall constructed with fiber-reinforced high-strength concrete were modeled with the authors' finite element code, *ParaAble*. Tests were experimentally staged at the Engineer Research and Development Center (ERDC). The fully coupled explosive-structural analysis used the recently developed AFC constitutive model (Ref. 1) for the fiber-reinforced concrete, the Johnson-Cook model for the reinforcing steel, and the programmed-burn JWL equation-of-state model for the C-4 explosive. All materials were modeled with the recently developed second-order brick elements (Ref. 2), and a single element was used to model the rebar cross-section. Fully integrated elements are used for the concrete and explosive materials, and a single layer of selectively-reduced integrated elements is used through the thickness of the reinforcing steel. An assumed quarter-symmetry mesh was used consisting of 110,896 elements and 920,157 nodes. The transient analysis was performed to 10.0 milliseconds. A scalar damage output variable, DAMDISP, was computed by inputting increments of effective inelastic strain into the pressure-dependent damage evolution relation of the Holmquist-Johnson-Cook model, and then computing displacement magnitudes of fully damaged elements. The damaged wall crater, predicted by post-processing of DAMDISP, compared favorably with the experimental observations. The analysis required approximately 5 CPU minutes on 256 cores of a Cray XE6.

[1] Adley, M. D., Frank, A. O., Danielson, K. T., Akers, S. A., and O'Daniel, J. L. 2010. The Advanced Fundamental Concrete (AFC) Model. ERDC/GSL TR-10-51. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

[2] Danielson, K. T. and O'Daniel, J. L. "Reliable Second-Order Hexahedral Elements for Explicit Methods in Nonlinear Solid Dynamics." *Int. J. Numer. Meth. Engng* **85**(9) 1073–1102. DOI: 10.1002/nme.3003

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