PROJECTILE PENETRATION INTO ULTRA HIGH PERFORMANCE CONCRETE: IS FIBER REINFORCEMENT REALLY EFFECTIVE?

Gianluca Cusatis[1], Jovanca Smith[2], Daniele Pelessone[3], James O'Daniel[4]

[1]Associate Professor, Department of Civil and Environmental Engineering, Northwestern University, Tech Building Room A125, Evanston, IL 60201; PH (847) 491-4027; email: g-cusatis@northwestern.edu; [2]Graduate Student, Department of Civil and Environmental Engineering, Northwestern University, Tech Building Room A323, Evanston, IL 60201; email: jsmith2014@u.northwestern.edu; [3]Chief Scientist, ES3, San Diego, CA 92101; email: peless@es3inc.com; [4]Research Engineer, Geotechnical and Structures Laboratory, U.S. Army Engineer Research and Development Center. Vicksburg, MS 39180; email: James.L.O'Daniel@usace.army.mil

Key words: High-Performance – Concrete – Penetration – Fragmentation – Fiber-Reinforcement

The effect of projectile penetration on a novel ultra high-performance concrete (UHPC) named CORTUF will be investigated in this paper using LDPM-F, the Lattice Discrete Particle Model for fiber reinforced concrete. This discrete meso-scale model can accurately describe the behavior of concrete in elastic, fracturing, fragmentation, softening, and hardening regimes. Material heterogeneity is represented in the model through the interaction of polyhedral cells with triangular facets defining their external geometry. At each facet, stress and strain vectors are used to formulate the model's constitutive law. Fiber crack-bridging effect is accounted for by considering the contribution of each individual fiber to the facet behavior.

The LDPM-F has been validated against a variety of experimental tests and can accurately replicate the response of concrete under both quasi-static and dynamic loading conditions. In this study, the variability of the penetration resistance of CORTUF is evaluated upon changing both model and geometrical parameters of a penetration problem consisting of a deformable steel cylinder impacting a CORTUF slab. Initial values of the parameters are obtained by fitting a series of experimental tests recently carried out at the Engineer Research and Development Center (ERDC). Assessment of the variability of the ballistic limit as well as of the penetration-induced damage distribution will be of particular interest in the analysis of the results.

Acknowledgement. This effort was sponsored by the US Army Engineer Research and Development Center. Permission to publish was granted by the Director, Geotechnical and Structures Laboratory. The work of the first and second author was also supported under DTRA grant No HDTRA1-09-1-0029 and NSF grant No 0928448, respectively.