Quantifying Damage Mechanisms in Ultra-High-Performance Concrete

Prof. Eric N. Landis

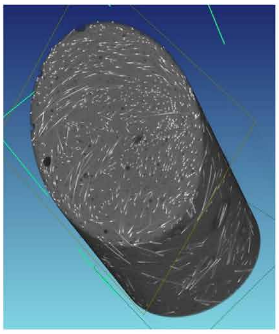
Civil Engineering, University of Maine, USA

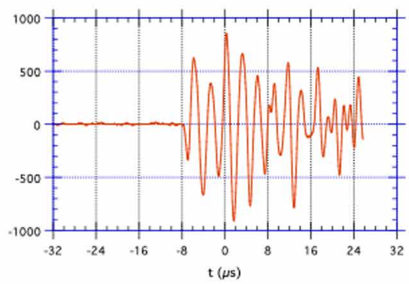
Am: **17. September 2024**

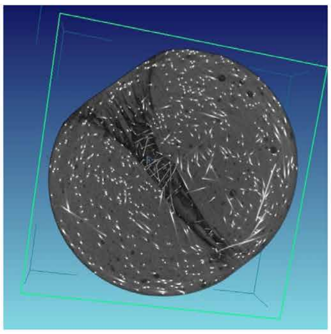
Um: **11:00** - 12:00 Uhr

Im: **IC**-Gebäude, Ebene **03**, Raum **604**, Ruhr-Universität Bochum

Ultra-high-performance concrete (UHPC) is a brittle matrix composite that exhibits high ductility thanks to the action of embedded steel fibers. The ductility is made possible by a number of well-known toughening mechanisms including, fiber-matrix debonding and pull-out, additional matrix cracking, as well as fiber bending and fracture. We are interested in quantifying these individual mechanisms not only to improve our predictive simulation capabilities, but also to provide a rational basis for materials design and optimization. In the work presented here, split cylinder fracture of steel fiber reinforced UHPC was examined using two complementary techniques: x-ray computed tomography (CT) and acoustic emission (AE). From the CT images, fiber orientation was evaluated to establish bounds for the effect of non-random fiber orientations. Analysis of differences in the CT images before and after loading showed that fiber pullout was the dominant energy dissipation mechanism, however, the sum of internal energy dissipation measured amounted to only 60% of the total energy dissipated by the specimens, meaning significant energy dissipation was missed. For the AE data, an artificial neural network-based approach was adopted to classify AE events as either matrix cracking or fiber pullout. While the CT analysis provided damage information at the end of the test, artificial neural network-based analysis of recorded AE waveforms provided information on the different dissipation mechanisms as they occur during the test. The AE data shows a shift in the dominant mechanism as the test progresses. While neither the CT nor the AE data provide an absolutely clear answer to the problem of damage evolution, when taken together, a more complete picture emerges.







Prof. Eric N. Landis

Eric N. Landis is Professor of Civil Engineering at the University of Maine. His research interests are in experimental mechanics, with particular focus on innovative laboratory techniques to capture mechanisms of failure in cement-based and wood-based composite materials. He also dabbles in computational modeling, biomimetics, burrowing marine invertebrates, and other things he should probably keep his nose out of. He has PhD and BS degrees in civil engineering from Northwestern University and the University of Wisconsin, respectively. Prior to his graduate work he spent several years in civil engineering consulting. He is a licensed Professional Engineer in the State of Maine.