Raul E. Marrero Rosa, Ph.D.

Associate II

Raul Marrero Rosa, Ph.D., is an Associate II within the Materials Consulting group at CTLGroup specializing in advanced cementitious materials and nanomodification techniques. Dr. Marrero's expertise focuses on the characterization and performance of ultra-high-performance concrete, fiber-reinforced composites, and additive manufacturing applications for structural materials.

Prior to joining CTLGroup, Dr. Marrero was a postdoctoral fellow at Northwestern University for three and a half years, where he advanced the development of Ultra-High-Performance Fiber Reinforced Concrete (UHPFRC) for 3D printed laminates. His doctoral research at Northwestern University focused on the interaction between carbon nanofiber reinforcement and cementitious composites using advanced characterization techniques including Atomic Force Microscopy, nanoindentation, and SEM/EDS. Dr. Marrero has also conducted research on sulfur-concrete, carbon fiber reinforced concrete, and cementitious volume changes at multiple scales.

Recent Research Projects

3D Printing of Offshore Wind Turbine Foundations with UHPC,
Orbital Composites Inc., CA | Oak Ridge National Laboratory, TN | University of Maine, ME | Northwestern University, IL

Collaboration project funded by the United States Department of Energy to optimize offshore wind turbine foundations using 3D printing of UHPC.

- Performed Discrete Fresh Concrete modeling of UHPC flow table and squeeze tests to develop a fluid-to-solid transition model using experimental data obtained at Oak Ridge National Laboratory
- Conducted one-month research residency at Oak Ridge National Laboratory to perform fresh state squeeze testing, early age compression, isothermal calorimetry, and ultrasonic pulse velocity measurements on multiple UHPC systems within the early age period (less than 3 days)
- Detected and correlated the fresh-to-solid transition period across different measuring techniques to validate computational models

Academic Credentials

Postdoctoral Fellowship in Civil Engineering, Northwestern University, 2025
Evanston, IL, USA

Ph.D. in Civil Engineering
Northwestern University, 2022

M.S. in Civil Engineering
Northwestern University, 2018

B.S. in Civil Engineering
Universidad de Puerto Rico - Mayagüez, 2016
Mayagüez, PR, U.S.A.

B.S. in Land Surveying and Topography,
Universidad de Puerto Rico - Mayagüez, 2016

Licensure & Certifications

Enrolled Professional Engineer Intern (E.I.T.) in Illinois, USA

Professional Affiliations

The American Ceramics Society (ACerS)

American Concrete Institute (ACI)

American Society of Civil Engineers (ASCE Member)

Contact Information

Office: (847) 972-3156
Email: rmarrero@ctlgroup.com

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Multi-Scale Additive Manufacturing of Ultra High-Performance Fiber Reinforced Concrete: Experiments and Computations, Northwestern University, IL

Three-year project aimed at nanomodifying the self-leveling UHPFRC mix developed by the United States Army Corps of Engineers (ERDC) to achieve “printability” within additive manufacturing systems.

- Led and trained graduate and undergraduate students in fresh state nanomodification using nano clay and characterization of flow behavior with Anton Paar Rheometer (Building Material Cell fixture), direct shear testing, green strength measurement, ultrasonic pulse velocity, and isothermal calorimetry
- Co-developed a UHPC capping technique to obtain parallel surfaces on 3D printed specimens, minimizing edge stress concentrations during testing
- Co-developed protocol using LiDAR 3D scanning to acquire surface topography of specimens prior to compression, split tensile, and flexural testing; transferred 3D scan surfaces to computational hardened models to analyze mechanisms generating experimentally observed anisotropic behavior
- Controlled steel fiber directionality within UHPC through flow direction to achieve 3D printed UHPFRC plates with cross-laminated and quasi-isotropic configurations
- Contributed to development of prototype dual extrusion system for extruding UHPC with continuous steel cable reinforcement following the printing path

Publications

- Irizarry, E. M., Gomaa, S., **Marrero, R. E.**, Ahmed, A., Burroughs, J. F., Kreiger, E., & Cusatis, G. (2025). **“Influence of surface geometry on the mechanical properties of the 3d printed ultra-high-performance concrete”**, Available at SSRN 5369360. (Under Review – Preprint Available)
- **Rosa, R. E. M.**, Bhibho, T., Dönmez, A. A., Cusatis, G., & Bažant, Z. P. (2024). **“The shard test and nanoporomechanics reverse classical paradigm of cement hydration being contractive”**, Proceedings of the National Academy of Sciences, 121(51), e2418448121.
- Gomaa, S., Irizarry, E. M., Ahmed, A., **Rosa, R. M.,** Ahmed, H., Burroughs, J., Kreiger, E., Liu, J., Troemner, M., & Cusatis, G. (2024). **“3D printing of ultra-high-performance concrete: Shape stability for various printing systems”**, Construction and Building Materials, 456, 139039.

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- **Rosa, R. E. M.**, Corr, D. J., Espinosa, H. D., & Shah, S. P. (2023). **"Characterization of adhesion strength between carbon nanotubes and cementitious materials"**, Cement and Concrete Composites, 138, 104953.
- Troemner, M., Ramyar, E., **Marrero, R.**, Mendu, K., & Cusatis, G. (2021). **"Marscrete: A Martian concrete for additive construction applications utilizing in situ resources"**, In Earth and Space 2021, (pp. 801-807).

Conference Paper

- **Marrero-Rosa, R.**, Irizarry, E., Ahmed, A., Yu, K., Brooks, A., Cusatis, G., & Alnaggar, M. (2026). **"Fluid to solid transition characterization of the 3d printed uhpc for offshore wind foundations"**, 4th International Interactive Symposium on Ultra-High Performance Concrete (UHPC) 2026. (Accepted conference paper)
- **Marrero, R. E.,** Soto, H. L., Benitez, F. R., Medina, C., & Suarez, O. M. (2017). **"Study of high-performance concrete reinforced with bamboo fibers**", TechConnect Briefs. Vol. 2, Materials for Energy Efficiency and Sustainability: TechConnect Briefs 2017, 301-304.