UTC Project Information	
Project Title	MPC-529 – Alternative in-situ Water-Cement Meter Using a Parallel-Plate Capacitor Concept
University	University of Utah
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Start and End Dates	September 30, 2013 to September 30, 2018
Project Duration	September 30, 2013 to September 30, 2018
Brief Description of Research Project	One of the best predictors of strength and performance for concrete is the water-to-cement (w/c) mass ratio. As useful as this number is, it is difficult to control the water content in the field because often time contractors will add unknown amounts of water to improve on-site workability of the concrete. If excess water was added on site, the strength and durability may be compromised. A challenge in the industry has been to have a device that can be used on-site before the concrete has hardened, which can accurately and precisely predict whether the water content has been increased. Currently Quality Assurance/Quality Control personnel are required to verify the water-to-cement ratio by performing one of two methods: either 1) take a sample of the fresh concrete to a laboratory site to perform the AASHTO T 318 standard for w/c ratio using a microwave, or 2) wait until concrete has hardened and test core samples in compressive strength to back-calculate an estimated w/c ratio. Both methods require samples to be taken off-site or waiting until after the concrete is hardened. The use of an in-situ w/c meter allows for an immediate on-site determination of the concrete mixture's w/c ratio. The company named NDT James has created a device called a Cementometer™, for which they have advertised as being "accurate" (James Instruments 2010) for estimating such on-site in-situ water-to-cement contents. However, statistical data using the device (shown in Figure 1), as tested by the Michigan DOT (Peterson and Sutter 2011)

	or preliminary testing at the University of Utah has indicated otherwise, that the device is not accurate nor precise. The theory behind how the Cementometer™ device appears technically sound, as it relies on a microwave frequency to create electromagnetic permittivity, of which a dielectric constant can be measured. The dielectric constant for water is significantly higher (around 80) than solids like cement and aggregates (around 2 through 11), and higher than air (around 1) (Nave 2012). As such, the net relative permittivity should correlate well with amount of free water in the concrete.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	From this research project, the main outcome will be a physical prototype device that has been calibrated against laboratory-created mixtures of known water-to-cement contents. From the literature search and development of the device, the background theory behind the microwave and dielectric permittivity-based technology is expected to be explained. The device from this project is anticipated to be presented to practitioners as an alternative device to be used in the field as a fast in-situ concrete quality assurance or quality control tool for concrete projects. Beyond the research report, it is expected that at least one journal paper be produced describing the technology behind the device and the limitations found, along with possible presentations at conferences such as the Transportation Research Board Annual Meeting, the Utah Department of Transportation Annual Research Conference, or a American Concrete Institute convention.
Impacts/Benefits of Implementation (actual, not anticipated)	Findings will be presented in courses taught at University of Utah: specifically 6225 Concrete Science and 7920 Advanced Materials Testing.

Web Links • Reports • Project Website	