UTC Project Information	
Project Title	Development of Mixture Designs for Pumpable Concrete for Extreme Weather
University	Oklahoma State University
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Funding Source(s) and Amounts Provided (by each agency or organization)	SPTC: $184,950 Oklahoma Department of Transportation SPR Funds: $184,950
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Agency ID or Contract Number	DTRT13-G-UTC36 SPTC 14.1-38
Start and End Dates	October 1, 2014 – September 30, 2016
Brief Description of Research Project	**PROBLEM**: With the recent budget crisis, US DOTs are trying to extend their construction funds while still providing long lasting and durable infrastructure. This is especially challenging in locations where there is extreme weather, as infrastructure is often replaced more frequently. In concrete structures, cement is the most expensive ingredient and the largest contributor to the carbon footprint. It can also lead to increased cracking through shrinkage. The initial cost and long term performance of concrete would benefit from the reduction of cement in concrete mixtures. **PROPOSED SOLUTION**: One area where states have begun to economize their construction materials is in the use of "optimized graded concrete". These concrete mixtures are designed to use less cement, and use proportionately more aggregate with a more controlled distribution of aggregate sizes. This aggregate control allows a concrete mixture to have increased workability and strength. However, research has shown that historic design techniques for optimized graded concrete do not work for all aggregate sources and that current DOT specifications are inadequate and do not ensure the benefits of optimized graded concrete. Another study has aimed to improve optimized graded concrete specifications for slip formed paving concrete. This research will extend the study to a larger number of materials and focus on the performance of these materials in extreme environments, specifically freezing environments. To provide freeze thaw durability to concrete, microscopic bubbles are added with specialized admixtures during the mixing process. These

	bubbles provide places for freezing water to escape once the concrete has hardened. During pumping it has been widely documented that the pressure cycles cause the bubbles to implode and then reform when the pressure is removed. Past research has shown that this process can coarsen the air void system in fresh concrete and ultimately threaten the freeze thaw durability of the concrete. This study will seek to better understand this process and ensure that frost durable concrete can be achieved. Implementation will allow immediate changes to be made to the optimized graded concrete specifications for structural concrete.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	
Impacts/Benefits of Implementation (actual, not anticipated)	
Web Links • Reports • Project website	