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CENTER FOR UNDERGROUND INFRASTRUCTURE RESEARCH AND EDUCATION

INNOVATION AND RESEARCH FOR WATER INFRASTRUCTURE FOR THE 21ST CENTURY: DURABILITY AND RELIABILITY OF LARGE DIAMETER HDPE PIPE FOR WATER MAIN APPLICATIONS

CUIRE at University of Texas at Arlington (UT Arlington) was awarded the research contract by WaterRF in November 2012 for the proposal titled *Durability and Reliability of Large Diameter (16 in. and larger) HDPE Pipe for Water Main Applications.* CUIRE is conducting this research in partnership with Benton & Associate (B&A), and Black & Veatch (B&V).

ACCOMPLISHMENTS TO DATE:

- Completed a literature search on large diameter HDPE pipe.
- Completed a nationwide survey of water utilities.
- Performed three expert workshops with water professionals.
- Completed nine case studies.
- Designed and started the experimental work.

PRESENT STATUS:

1. **Literature Search –** The literature search is completed with more than 70 citations found through Engineering Village, ProQuest, No-Dig, and ASCE databases. The findings are classified into: Manufacturing; Permeability; Thermal Expansion; Leakage; Fatigue Resistance; Durability; Oxidation; Water Quality; Seismic Resistance; Tensile Resistance; Use of Trenchless Technologies; Installation and Case Studies. The literature search provided information on the benefits and limitations of HDPE pipe compared with other pipe materials used for water applications. The findings helped the project team to conduct a survey of water utilities, and develop a testing plan.

2. **Survey –** A survey was sent to water utilities to collect information on the application of large diameter HDPE pipe in actual field conditions. The survey asked questions on restrictions of using and installing HDPE pipe, leakage issues, causes, rates and modes of HDPE pipe ruptures, environmental and maintenance aspects of the large diameter HDPE pipes, and so on, as they may influence reliability and durability of the large diameter HDPE. Web-based software called "Survey Monkey" was used to send out the survey. This software is a simple and useful tool to gather survey results and analyze them. The survey was sent to more than 350 utilities across the United States, and 101 responses have been received. Overall, most of the utilities are satisfied with use of HDPE pipe. Nonetheless, there are concerns with service connections and tapping, repairs, permeation, and oxidation.

3. **Workshop with Water Professionals (Expert Workshop) –** Workshop #1 was held on April 12, 2013, in Springfield, Mo. This Expert Workshop provided valuable input to the project and assisted the project team to improve the project scope and experimental approach. The structured approach used for the workshop allowed the critical topics to be identified in an efficient manner. The time of participants was devoted to discussion of research goals and methodology. This workshop enabled the project team to explore different perspectives and identified several studies and experiences brought up by the workshop participants.

Workshop #2 was held on June 10, 2013, in Denver, in conjunction with ACE 2013. Workshop #3 was held on June 23, 2013, in Fort Worth, Texas, in conjunction with the ASCE Pipelines 2013 Conference. The main objectives of Expert Workshops 2 and 3 were to obtain as much input as possible from the participating industry professionals from water utilities, HDPE manufacturers/vendors and Plastics Pipe Institute (PPI) representatives by conducting small and large group discussions.

4. **Experimental Work –** The objectives of the experimental task are to conduct high pressure cyclic loading fatigue test on new HDPE pipes with a joint. The results of the tests will be compared with manufacturing specifications (in particular to pressure ratings of the pipes) and design information of these pipe materials. The fatigue tests will enable the research team to determine whether a 16-in. diameter HDPE (DR 17) or 18-in. diameter HDPE (DR 21) can withstand cyclic loads that are 1.5 times higher than the long-term pressure rating of the pipe for an extended period of time (two million cycles with a 7- to 10-second period). The setup comprises of a water supply tank, multi-stage centrifugal pump (10 HP), data acquisition system, control board, pressure transducers, DC power supply, specimen (16-in. & 18-in.), and control valves including back flow pressure and solenoid valves. Currently a cycle time of between 7 to 10 seconds is achieved; dependent on the water temperature. Currently, 47,000 cycles for the 16-in. (DR 17), 15-ft long pipe, between 125 psi and 188 psi are completed. The project team currently is designing a cooling system to maintain the water temperature at 70 F. with 7 to 10 seconds per cycle, it is estimated that 2 million cycles will take five to six months to complete.

5. **Perform Case Studies –** The Project Team started to gather information about actual large diameter HDPE transmission main projects from the beginning of this study. The Project Team contacted a number of water utilities (public and private) and engineers/managers that were involved in HDPE transmission main projects. In addition to finished/raw drinking water transmission mains, HDPE transmission pipelines used for irrigation, and for one case, brine solution conveyance were also included as the pipelines used in these types of projects operate under very similar conditions to that of drinking water transmission mains.

These case studies collected so far include the following projects:

a. Yankee Lake, Seminole County, Fla.

b. Silver Lake Transmission Main, Los Angeles.

c. Loch (Lake) Katrine Water Project, Glasgow, Scotland.

d. MTD Pipeline, Manistee, Mich.

e. Gatehampton Borehole Upgrade, United Kingdom.

f. Eastern Navajo Water Pipeline, Navajo Reservation, N.M.

g. Transmission main (36-in.) in Houston.

h. Fisher Island Transmission Main, Miami Dade County, Fla.

i. Regional Carizzo Project, San Antonio, Texas.

6. **Final Report –** As per amended schedule, our draft final report is due on Aug. 15, 2014, and the final report is due on Jan. 15, 2015. These reports will include literature review, project workshops, utility survey, case studies, experimental work (materials, methods, and results), and conclusions drawn upon all of the tasks mentioned above.

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- CE 5345. Infrastructure Evaluation, Maintenance and Rehabilitation
- CE 5300 Public Private Partnerships (P3)
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For more information, contact Dr. Mohammad Najafi, P.E., F. ASCE, at ph: (817) 272-0507 or email: *najafi@uta.edu*.

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