Trenchless Technology Center Newsletter

MARCH 2011

LinerRite – Innovative NDT Method for Quality Control of CIPP Liners

LinerRite is an innovative, patent-pending, sensory system capable of estimating the degree of saturation (during wet-out) and mechanical strength (in-situ) of CIPP liners, without the need for destructive testing.

The technology has two primary applications. The first application is in the control and optimization of the resin impregnated into the liner during the wet-out process. The technology differentiates zones of high and low density resin content with accuracy sufficient to identify resin deprived regions within 10 percent of the optimum saturation level.

The second application is to provide an estimate of the mechanical characteristics of a cured CIPP liner in-situ. Following a comprehensive calibration procedure, a combination of optical and contact measurements is used to estimate key mechanical properties of the installed liner such as flexural strength and tensile elastic modulus.

An Alfa prototype of the system has been constructed and assembled on a robotic platform, and custom software (LinerRite V1.1) with an interactive graphical user interface was developed. The software provides seamless interaction with the optical and contact sensors and supports rapid calibration of the system for a given resin system. The TTC is currently developing an extensive resin database in support of the development of the LinerRite system.

Testing Program

The LinerRite was tested on CIPP liners prepared with three different commercially available resins. Felt panels were prepared using the resin in the amounts required to achieve impregnation levels ranging from 0.5 lb/ft to 3.0 lb/ft, in increments of 0.5 lb/ft. Specimens were prepared for the calibrating of the system as well as for performing ASTM D638, ASTM D790 and ASTM D2240 tests.

Fig 1. Roller system (left), impregnated panels (middle), and mechanical testing (right)

Based on experimental measurements the tensile elastic modulus and bending modulus of elasticity were calculated for each specimen. For the spectral test, 10 specimens were prepared for each level of impregnation. Nine readings were performed on each specimen, for a total of 90 readings for each resin type. Thirty hardness readings were performed using a random pattern for each specimen (i.e., 300 readings for each impregnation level). Average values were used to compute the mathematical relationships between the spectral and mechanical characteristics of each of the three resins.

The relationships between the spectral value and (a) resin amount used per linear foot, (b) hardness, (c) tensile modulus of elasticity, and (d) bending modulus of elasticity were developed for each of the three types of resins tested. From the graphs, it can be seen that these relationships are linear.

Fig 2. Testing Matrix

Test Type	Data Points per Specimen	Number of Test Specimens							Data Points per Resin Type
		T1	T2	T3	T4	T5	T6	T7	
ASTM D638	1	5	5	5	5	5	5	5	35
ASTM D790	1	5	5	5	5	5	5	5	35
Spectral Test	9	10	10	10	10	10	10	10	550
Hardness	30	10	10	10	10	10	10	10	1890

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Software Development

Custom software was developed for the LinerRite system using Microsoft Visual Basic, VB2008. The program supports semi-automated calibration for new resin systems, contains a database from which values for previously entered resin system information can be retrieved, and provides graphical representation of the relations among key characteristics for the resin system in question. In addition, the software alert the operator if a pre-determine threshold value in terms of resin saturation deficiency or minimum estimated mechanical strength value is exceeded. A prototype of the LinerRite sensor mounted on a robotic arm is shown in Figure .

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LinerRite can be employed during wet-out processes to optimize the amount of resin used in the liner preparation. It can also be used as a cost-effective, non-destructive approach for QC/QA of CIPP liners during the wet-out process of a CIP liner (i.e., detection of poorly impregnated zones) and the detection of resin-deprived and/or under-cured sections in an installed CIPP liner. While LinerRite's accuracy is insufficient to serve as acceptance/rejection criteria, it is the first QC tool for CIP liners that provides QC information about the liner along its entire length in a continuous manner. For additional information regarding LinerRite pleases contact Dr. Erez Allouche (*allouche@latech.edu*) or Shaurav Alam (*sza003@latech.edu*).

Fig 3 A prototype of the LinerRite sensor mounted on a robotic platform during laboratory tests

Municipal Forums

TTC Research Engineer Jadranka Simicevic headed up a highly successful Fall 2010 Municipal Forum series hosting forums in Westminster (47 participants), Portland (60), Boston (49), Dallas (74), Miami (55), Fairfax (34), Santa Ana (80), and Palo Alto (39). These forums partnered the TTC with the host municipality to identify and address local trenchless technology issues through a series of presentations and discussions. The Spring 2011 Municipal Forum series is scheduled to kick off with a forum in Colorado on April 7, followed by forums in Minnesota on April 20, New York on May 19, Ohio on May 24, the Northwest (location/date TBA), Houston (date TBA), plus one other in a new location to be deciwded later. Since the fall of 2010, online registering for the forums is available at *www.ttcmf.com*.

TTC Welcomes New Staff

TTC has hired a new full-time Administration Coordinator, — Fredda Wagner — to help the TTC staff with our expanding Municipal Forum series and our expanding research efforts. Both the forums and the research programs generate significant organizational challenges. Wagner brings more than 10 years of administrative experience to the TTC. She will be working closely with TTC long-time Office Manager Sandi Perry and Research Engineer Jadranka Simicevic to maintain and expand TTC's efforts.

Fredda has taken this opportunity to tell us about herself: "Hi, I am Fredda Wagner. I am glad to be joining the TTC research team as administrative support. After working for the LA Tech bookstore for the past six years, I decided that it was time for a career change. I have lived in Ruston, La., most of my life and attended college at LA Tech University for some time before graduating from University of Louisiana at Monroe. I have worked at all neighboring local area colleges; University of Louisiana at Monroe, Grambling State University and here at LA Tech University. I look forward to facing new challenges with the TTC, as well as being a great asset to their team."

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