C-LTPP DATABASE: HOW CAN WE CAPITALIZE ON THIS VALUABLE DATA?

Richard Korczak, P.Eng, M.A.Sc.;

Susan L. Tighe, Ph.D., P.Eng, Professor and Norman W. McLeod Chair in Sustainable Pavement Engineering;

Centre for Pavement and Transportation Technology, Civil and Environmental Engineering, University of Waterloo, ON, Canada, N2L 3G1

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Introduction

- In 1989, the C-SHRP (Canadian-Strategic Highway Research Program) launched a national full scale field experiment known as the Canadian Long-Term Pavement Performance (C-LTPP) program.
- Between the years, 1989 and 1992, A total of 24 test sites were constructed between 1989 and 1992 for a total of 65 sections.
- The majority of the overlays used Hot-Mix Asphalt Concrete (HMAC). Several sections used HMAC with the addition of polymer, or a high friction mix, and several others used Reclaimed Asphalt Pavement (RAP).
- The C-LTPP program attempted to design and build the test sections across Canada so as to cover the widest range of experimental factors such as traffic loading, environmental region, and subgrade type. The environment types include Wet-No Freeze, Wet-Freeze and Dry-Freeze.

Objective

- Calculate the dynamic modulus (|E*|) for the C-LTPP test sections.
- E* is a fundamental property that defines the stiffness characteristics of hot mix asphalt mixtures as a function of loading rate and temperature.
- Dynamic modulus is one of the primary material property inputs in the Mechanistic-Empirical Pavement Design Guide (MEPDG).
- The dynamic moduli will be determined using artificial neural networks (ANNs) developed under a Federal Highway Administration (FHWA) study.

Figure 2: C-LTPP Database Hierarchy

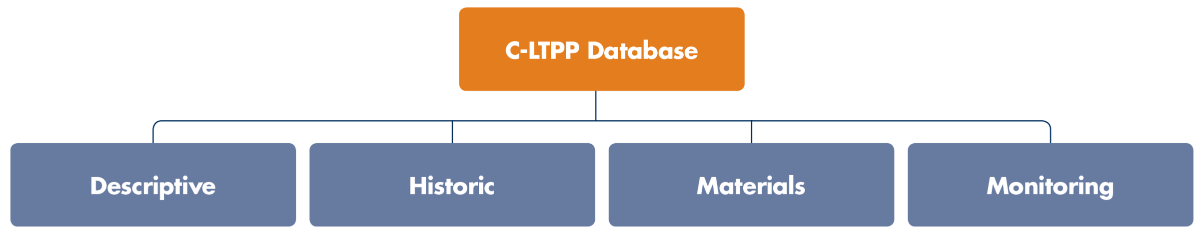
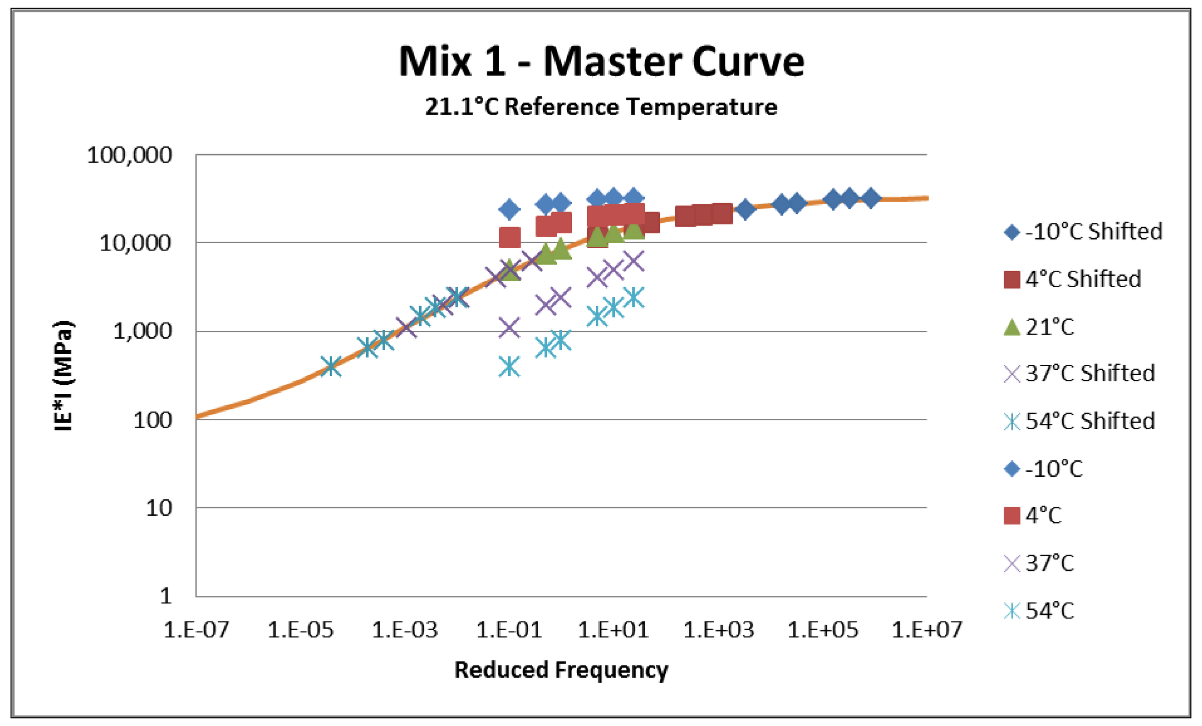


Figure 3: Artificial Neural Network Diagram



Background

- Prior to 2011, the only dynamic modulus predictive equations were the original Witczak equation, the modified Witczak equation and the Hirsch model.
- An FHWA study determined that no single model was capable of predicting the dynamic modulus over the complete range of necessary conditions accurately.
- Three ANN models were developed using resilient modulus, mixture volumetric properties and binder properties. Overall, the three ANN models were found to provide better predictability than any of the closed-form solutions.

Figure 4: ANN Model Order of Preference

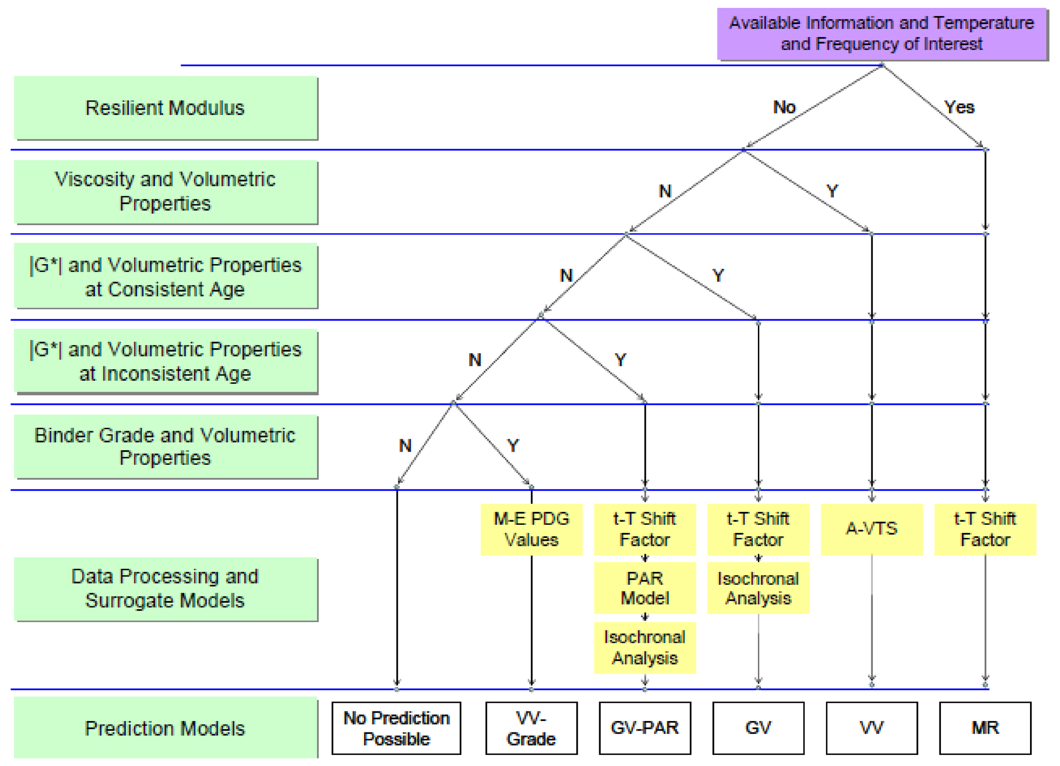
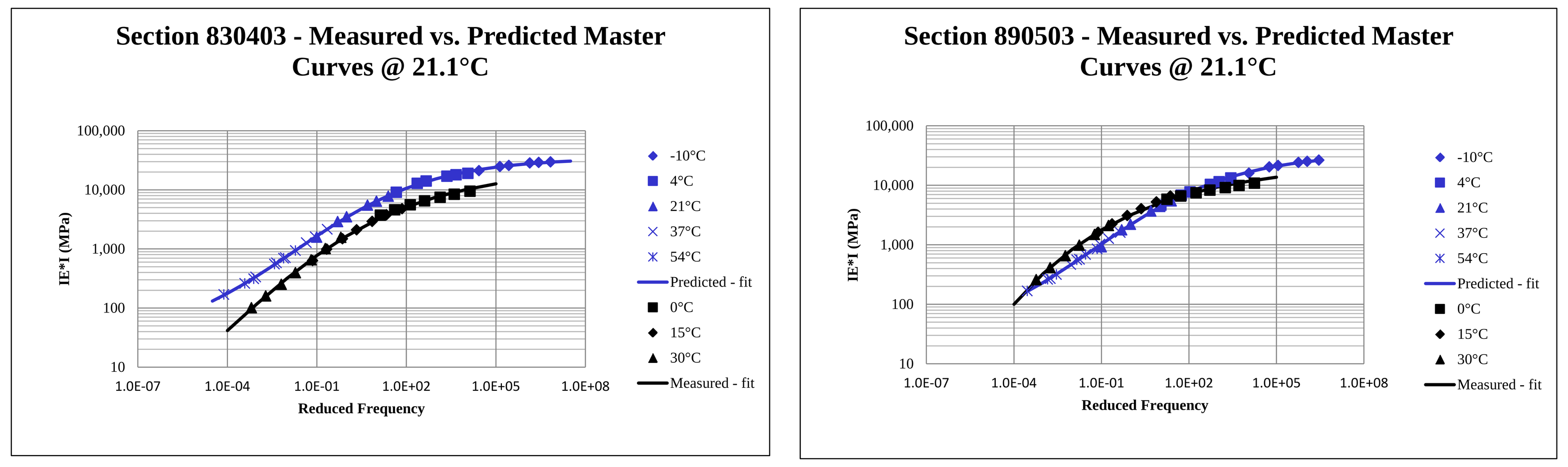


Figure 5: Dynamic Modulus – C-LTP Predicted vs. Measured Test Sections



Supplemental Data

- Supplemental data was obtained from previous research completed in UW Doctoral Theses to support Section 890503 findings.

Figure 6: Supplemental Mix Data

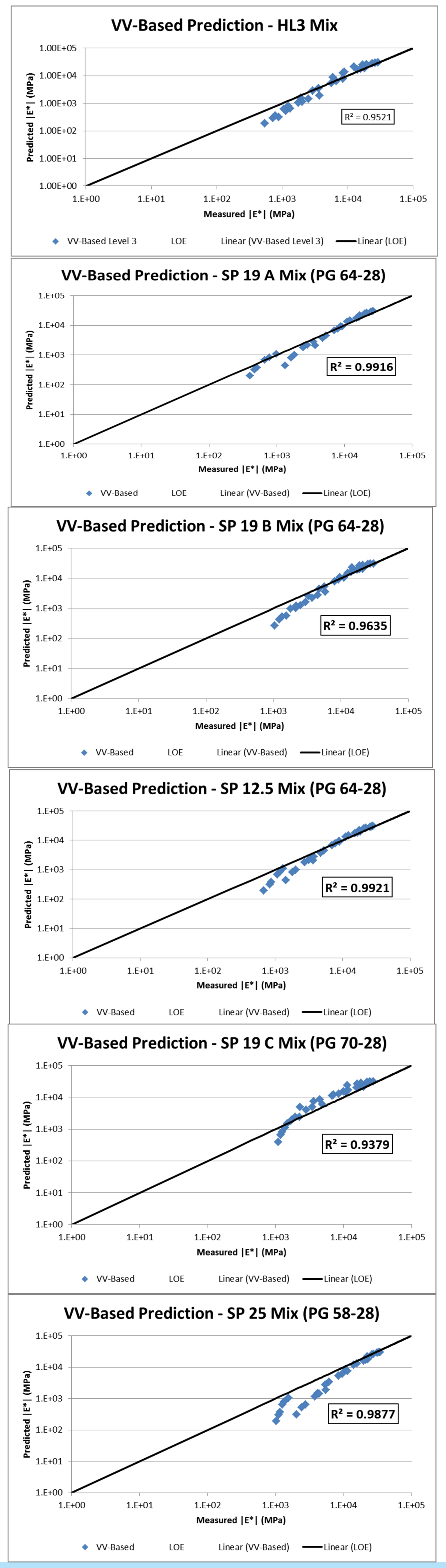
Mix Type	Binder Grade
Hot Laid 3 (HL3)	PG 58-28
Superpave 12.5 (SP 12.5)	PG 64-28
Superpave 19 (SP 19 A)	PG 64-28
Superpave 19 (SP 19 B)	PG 64-28
Superpave 19 (SP 19 C)	PG 70-28
Superpave 25 (SP 25)	PG 58-28

Figure 7: Supplemental Mix Data – Statistical Analysis

Mix Type	Binder Grade	R^2	Student's t-Test: p-value Testing Temperature				
			-10°C	*4.4°C*	*21.1°C*	*37.8°C*	*54.4°C*
Hot Laid 3 (HL3)	PG 58-28	**0.95**	0.10	0.31	0.82	0.10	0.062
Superpave 12.5 (SP 12.5)	PG 64-28	**0.99**	0.13	0.44	0.45	0.091	0.041
Superpave 19 (SP 19 A)	PG 64-28	**0.99**	0.043	0.32	0.61	0.16	0.77
Superpave 19 (SP 19 B)	PG 64-28	**0.96**	0.087	0.57	0.79	0.10	0.032
Superpave 19 (SP 19 C)	PG 70-28	**0.93**	0.013	0.13	0.078	0.46	0.54
Superpave 25 (SP 25)	PG 58-28	**0.99**	0.36	0.20	0.058	0.0039	0.0021

Conclusions

- Several improvements can be made to help achieve C-SHRP's goals of developing improved methodologies and strategies in the rehabilitation of flexible pavements and developing pavement performance prediction models.
- The Viscosity-based ANN model provided dynamic modulus values that correlate well with measured values from the lab.
- There is a rich base of information still to be harvested from C-LTPP studies that will aid in improving the performance of pavements. The C-LTPP program will provide benefits and deliver accomplishments for the foreseeable future.



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