



A Model to Predict Creep Compliance of Asphalt Mixtures (18-04715)

Fazal Safi, Kamal Hossain, Shenghua Wu, Hasan Ozer

Adviser: Imad Al-Qadi

University of Illinois at Urbana-Champaign

97th Transportation Research Board Annual Meeting



Illinois Center for Transportation

University of Illinois at Urbana-Champaign

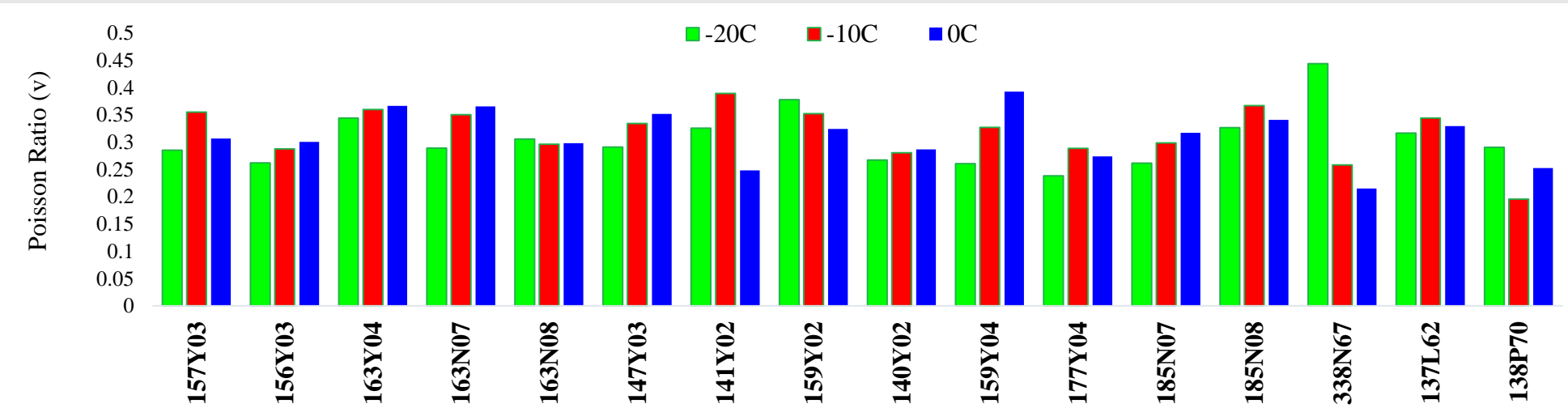
Research Objectives

- The purpose of this study is to investigate the effect of reclaimed asphalt pavement (RAP), recycled asphalt shingle (RAS), steel slag, and recycled concrete aggregate (RCA) on thermal cracking susceptibility using IDT Creep Compliance.
- Propose a new model to capture the effect of asphalt binder replacement (ABR) on Creep Compliance, which was previously not captured in MEPDG model, and other modified models.

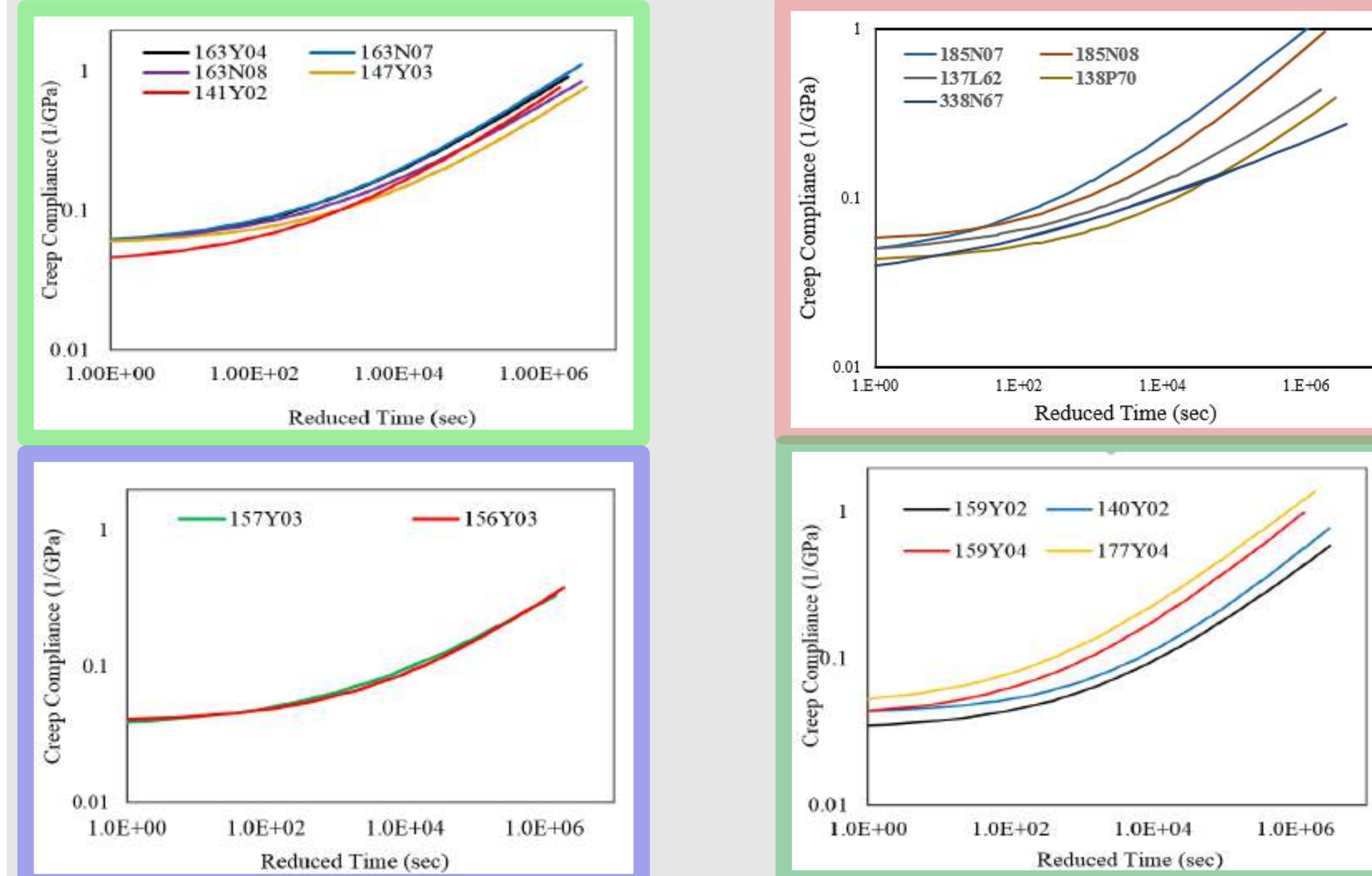
Mixes Information

Mix Type	ABR, %	RAS, %	RAP, %	Virgin PG	AC, %	VMA, %	#200 passing
163Y04-LB	29	5	24	70-28	8.1	21.73	6.3
163N07-LB	29	5	24	70-28	8	21.44	6.3
163N08-LB	29	5	24	70-28	7.7	21.04	6.1
147Y03-LB	35	5	33	70-28	8	21.47	6.4
141Y02-LB	32	5	29	70-28	7.7	21.05	7
156Y03-SM	15	2.5	5	64-22	5.6	16.61	4.7
157Y03-SM	29	5	10	58-28	5.7	16.85	5.5
159Y02-SM	29	0	34	58-28	6	17.34	6.1
140Y02-SM	30	3.1	20	58-28	5.5	16.35	4.6
159Y04-SM	29	0	34	58-34	6	17.31	6
177Y04-SM	30	3.1	20	58-34	6.6	17.98	6
185N07-SM*	48	5	39	52-28	6.3	17.37	6.6
185N08-SM*	48	5	39	52-34	6	17.33	6.6
137L62-SM*	60	4.6	51	52-28	6.7	18.03	6.8
138P70-SM*	37	0	27	52-28	5.5	19.62	5.5
338N67-SM*	56	5	53	58-28	6.6	17.65	6.6

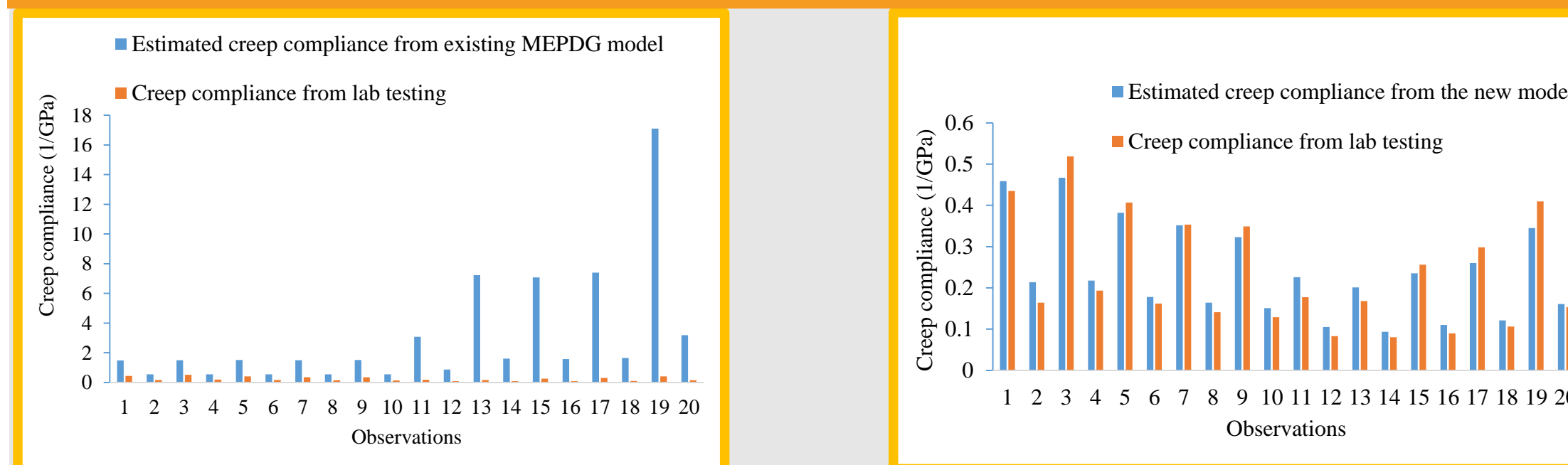
*Total recycled asphalt (total recycled aggregate with high ABR). It also contains steel slag of 27, 27, 14, 68.3 & 15%, respectively and recycled concrete aggregate of 27 & 30% in 338N67 & 137L62, respectively. SM= Surface Mix, LB= Leveling Binder



Creep Compliance Analysis



Creep Compliance Modeling



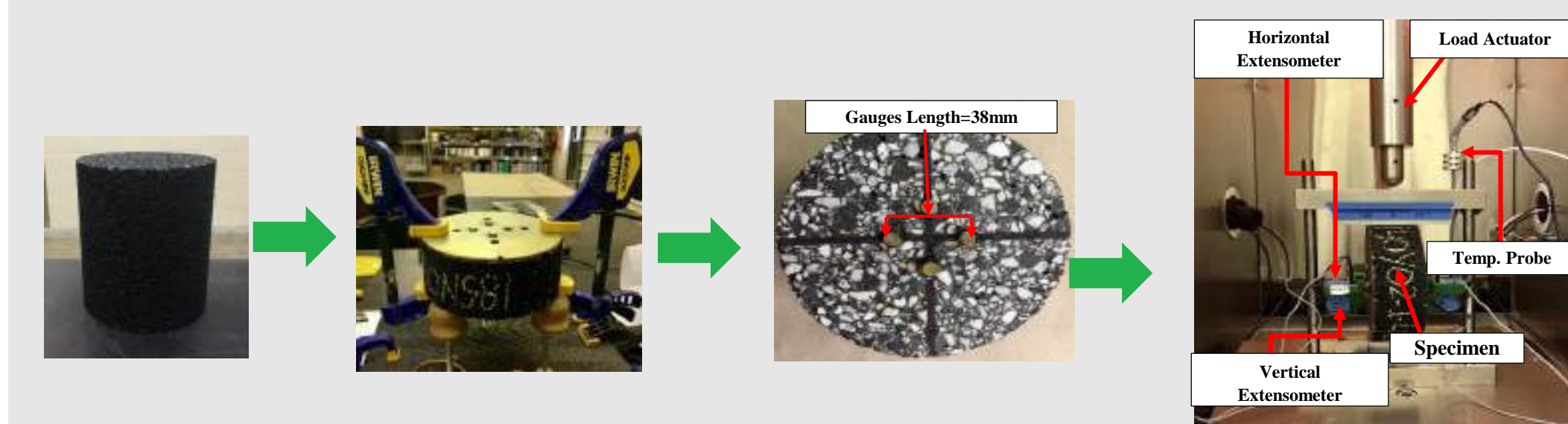
$$\text{Log}D_{t=} = -4.650 + 0.031 \times T + 0.469 \times V_a - 0.028 \times \text{VMA} + 0.101 \times \text{AC} - 0.007 \times \text{ABR} + 0.100 \times \% \text{ Passing \#200 Sieve} - 0.012 \times \text{Rotational Viscosity} + 0.188 \times \text{Log}(t)$$

Variables	Coefficients	t-stat (t-critical 1.96)
Intercept	-4.650112	-12.30
Test Temp (°C)	0.030584	50.27
% Va	0.469163	7.86
% VMA	-0.028316	-3.94
% AC	0.100573	3.86

Statistical Results

Variables	Coefficients	t-stat (t-critical 1.96)
% ABR	-0.006983	-9.83
% Passing # 200	0.099840	6.25
Rotational Viscosity (Pa-s) ^{135°C}	-0.011550	-0.18*
Log (t)	0.187828	36.46
N and R-squared	480, 0.90	

IDT Test Setup



Summary

- Creep compliance increases with time, temperature, and softer binder, but it decreases with recycled materials (RAP and RAS).
- Leveling binders are more compliant as expected, and intended for retarding reflective cracking.
- TRA mixes are stiffer and less compliant, due to high ABR, steel slag, and RCA.
- Generally, Poisson's ratio increases with temperature.
- The proposed creep compliance is capable to capture ABR, and found to be feasible.
- The model is successfully validated, have high R-square=0.90, and RMSE= 0.03 1/GPa.

Acknowledgement

- The poster is based on the results of R27-161 project, Construction and Performance Monitoring of Various Asphalt Mixes in Illinois and was conducted in cooperation with the Illinois Center for Transportation; the Illinois Department of Transportation, Division of Highways; and the U.S. Department of Transportation, Federal Highway Administration.
- J. Trepanier, T. Zehr, B. Pfeifer, R. Sheley, J. Vespa, L. Rowden, G. Houston, D. Bachman, J. Meister, G. Renshaw and ICT students