

Asphalt Mix Testing: Design, Construction & Performance Measurement Needs

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Acknowledgements
 AAPT Leading Edge Workshop – March 2016

- **Presiding Officer:** Gaylon Baumgardner
- **Moderator:** Professor Carl Monismith
- **Panel Members:** Imad Al-Qadi, Bill Buttlar, Rita Leahy, Richard Kim, Jon Epps, Louay Mohammad, Rey Roque, Fujie Zhou [All contributed content used in the presentation, and slides 6 to 14 are a very abbreviated version of that presentation]
- Several AAPT Past Presidents, Established Members, and Newer Members Also Contributed to the Workshop Program



Construction Materials Research Center (CMRC) Overview

- Housed within Civil and Environmental Engineering (CEE) department. <http://www.cee.msstate.edu/cmrc/>
- 31 entities have contributed to CMRC's endowment.
- Two meetings per year. A variety of issues associated with construction materials are discussed at general meetings, PDH presentations are given at some meetings, and anyone is welcome to attend.
- Emails are sent around periodically, and anyone who is interested in getting on this email distribution list can send an email to ilhoward@cee.msstate.edu indicating you want to be added to the list.

This Boils Our Mix Testing Challenge Down Pretty Well

*We Do Three Types of Jobs Here...
GOOD, FAST AND CHEAP
 You May Choose Any Two!*

If It Is Good and Cheap
 It Will Not Be Fast.

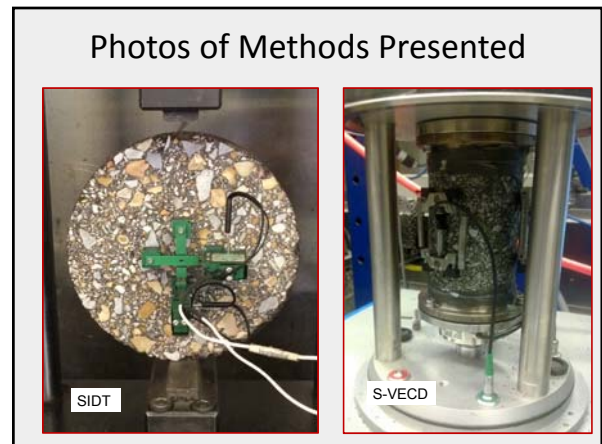
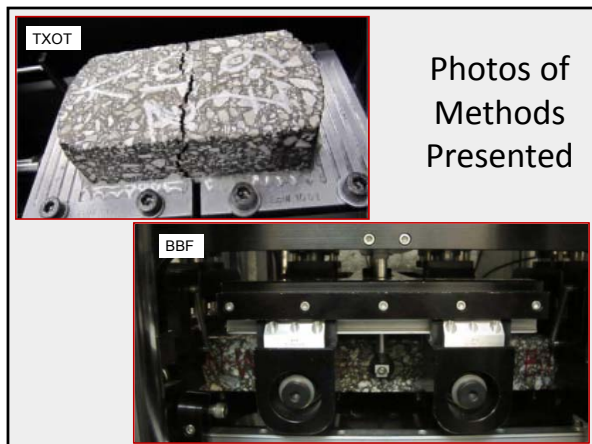
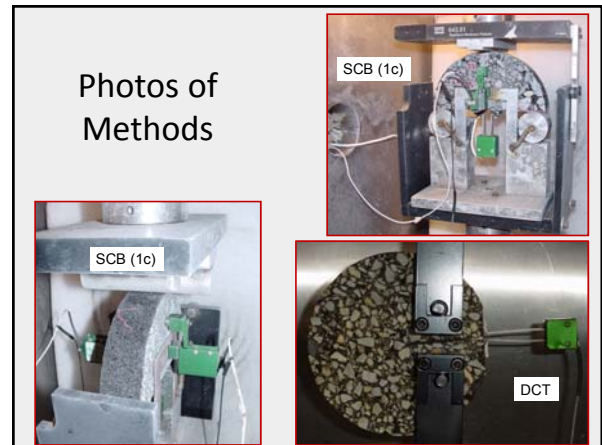
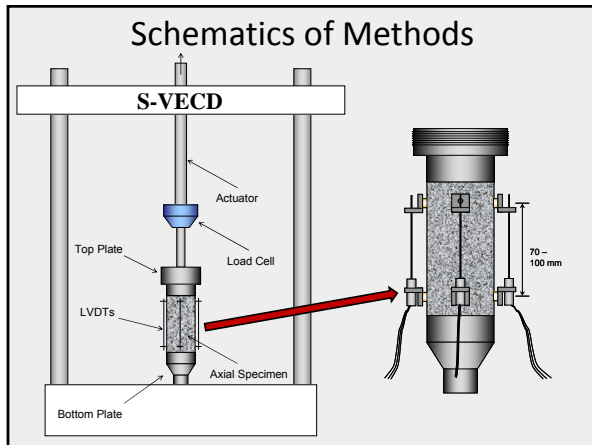
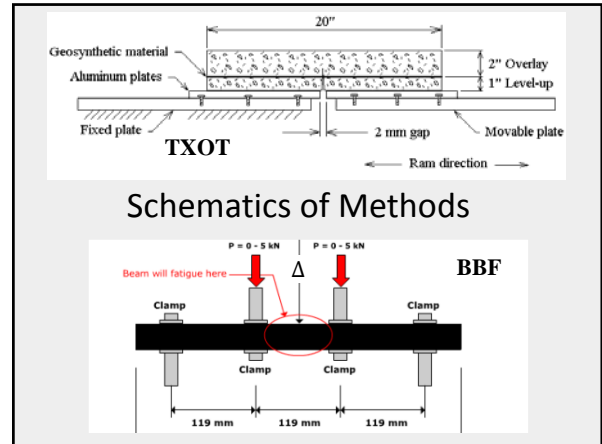
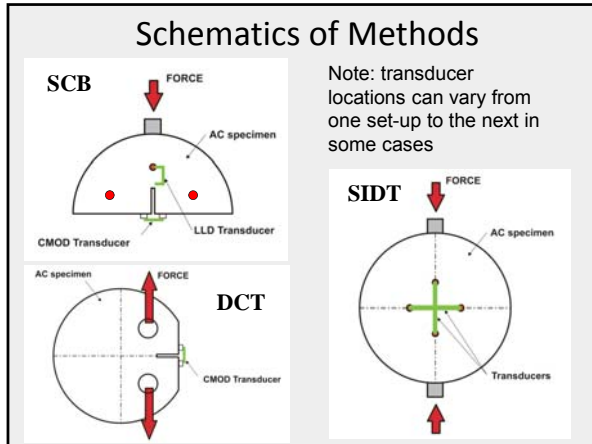
If It Is Good and Fast
 It Will Not Be Cheap.

If It Is Fast and Cheap
 It Will Not Be Good.



Summary of Methods Presented at AAPT Leading Edge Workshop

- 6 categories of methods, 8 test methods
 1. Semi-Circular Bend (SCB)
 - a. LTRC (Intermediate Temperature)
 - b. Illinois Flexibility Index Test (I-FIT)
 - c. Minnesota (Low Temperature)
 2. Disc-Shaped Compact Tension (DCT)
 3. Bending Beam Fatigue (BBF)
 4. Texas Overlay Test (TXOT)
 5. SuperPave Indirect Tensile Test (SIDT)
 6. Simplified Viscoelastic Continuum Damage (S-VECD)



Method	Test Protocol	Specimen Dim. (cm)	Test Temp (°C)	Output(s)
SCB (1a)	LA TR 330	5.7(t), 15(d)	25	Crit. Strain Energy Rel. Rate (I_c)
SCB (1b)	PT 124 IL 405	2.5-5(t), 15(d)	25	Fracture Energy (G_f), Flexibility Index (FI).....
SCB (1c)	TP 105	2.5(t), 15(d)	Low PG+10 & Low PG -2	Fracture Toughness (K_{Ic}), Stiffness (S), G_f
DCT	D7313	5(t), 15(d)	≤ 10 (typical)	G_f
BBF	T321	6.3(w), 5(t), 38(L)	20	Cycles to 50% stiffness loss (N_{50})
TXOT	Tex-248-F	15.2(L), 7.6(w), 3.8(t)	25	Cycles to failure
SIDT	T322 and TP Draft	3.8-5(t), 15d	-30 to 20	Creep Compliance, Fract. Limits, Energy Ratio
S-VECD	TP107	10.2(d), 13 OR 15.2(h)	Avg PG High & Low -3	Several, including fatigue and thermal cracking

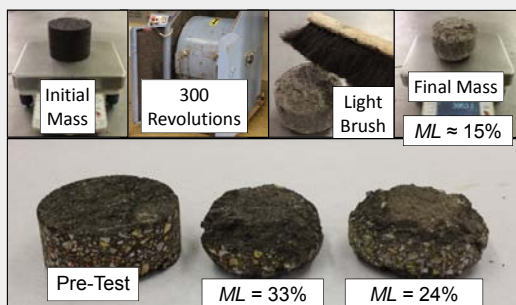
t = thickness, d = diameter, h = height, w = width, L = length
T, TP, PT are AASHTO, D is ASTM, IL is Illinois, LA is Louisiana DOTD, Tex is Texas

Overall Summary of AAPT LEW Relative to These Methods

- All methods related to **cracking**
- The majority of these methods have some data on their relationship to field performance
 - Data sets and prediction quality vary in some cases, but the bottom line is these methods have been vetted
 - These methods lean toward the **good**, not as much toward **fast**, and sometimes not toward **cheap**.

Cantabro Test Method on DGA

(Very **Fast**, Pretty **Cheap**, Perhaps not as **Good**)



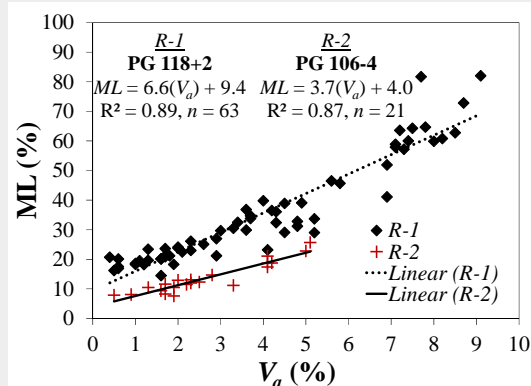
Cantabro Test

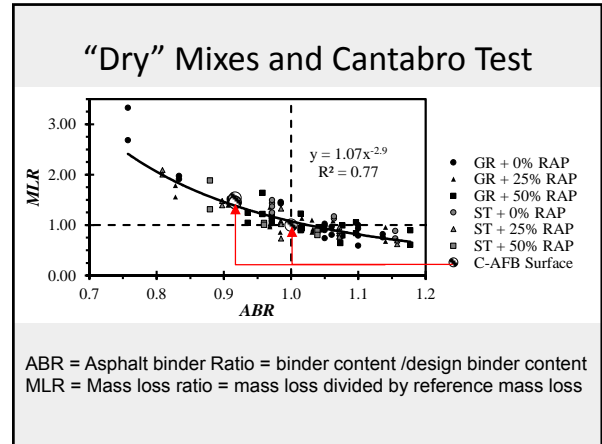
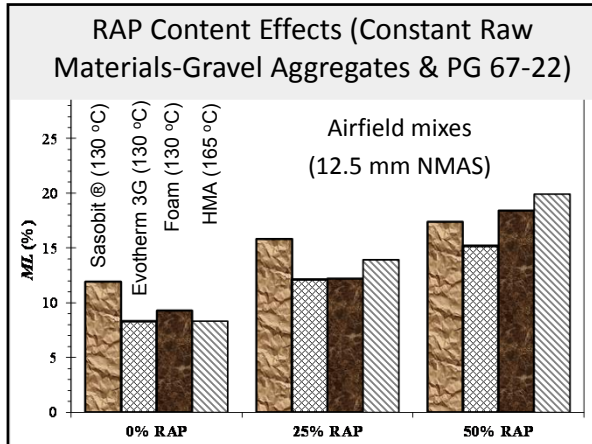
- Historically used for OGFC or PFC, **BUT** that does not mean that is all the Cantabro test is useful for
- Cantabro test has been successfully used for projects (see SEAUPG 2014 presentation)
- A **key attribute** of the Cantabro test is the most likely undesirable issues to be encountered during production all make **mass loss increase** (some other tests can have increased or decreased outputs depending on the situation)

Cantabro Test and Present Day Paving

- We are producing "dry" mixes
- We know (and have for decades) general principles that lead to more durable mixes, but during production, we don't always fully incorporate these items
 - Fine Graded Mixes
 - Enough VMA
 - Softer binders (just hard enough not to rut)
 - Dust Control
 - Low Air Voids
 - Use of Polymers.....(others)
- Presenter's Opinion:** Cantabro test is a brittleness index that considers (**good**, **fast**, and **cheap**) at least comparable to any other alternative in the industry when talking about **mixture production**

100% RAP and Virgin Binder





Binder Grade and Polymers

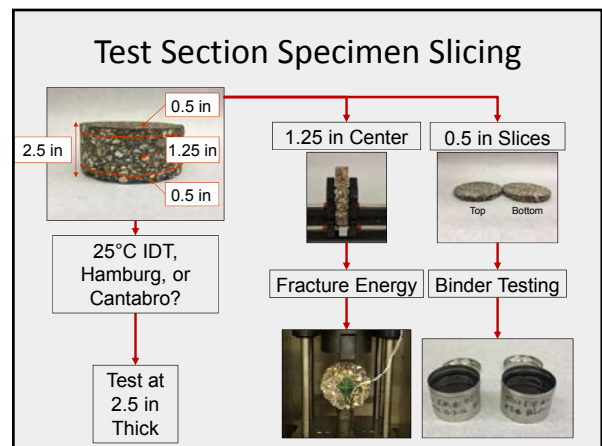
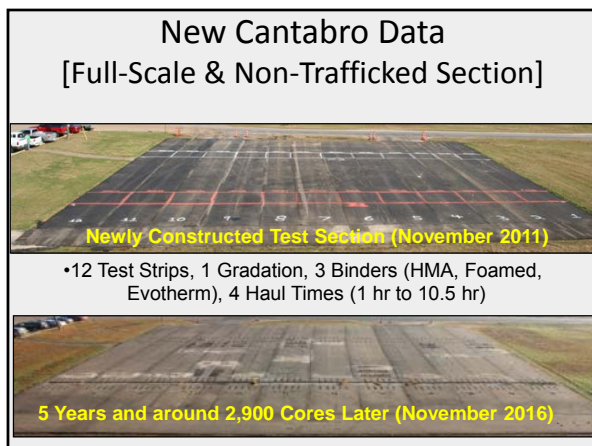
- Lots of different types of mixes and different amounts of replication

High PG Grade	Avg ML (%)	Specimens
64	9.1	6
67	11.5	485
70	16.0	18
76	9.2	119

References

(Most of the Data Presented to Date Was Collected for Other Studies and is Already Published)

- Baumgardner, G.L., Hemsley, J.M., Jordan, W., and Howard, I.L. (2012). "Laboratory Evaluation of Asphalt Mixtures Containing Dry Added Ground Tire Rubber and a Processing Aid," *J. Association of Asphalt Paving Technologists*, 81, 507-539.
- Doyle, J.D. and Howard, I.L. (2010). "Laboratory Investigation of High RAP Content Pavement Surface Layers," Report FHWA/MS-DOT-RD-10-212, Mississippi Dept. of Trans., Jackson, MS.
- Doyle, J.D., Mejias-Santiago, M., Brown, E.R., and Howard, I.L. (2011). "Performance of High RAP-WMA Surface Mixtures," *J. Association of Asphalt Paving Technologists*, 80, 419-457.
- Doyle, J.D. and Howard, I.L. (2011). "Evaluation of the Cantabro Durability Test for Dense Graded Asphalt," *Proc. of Geo-Frontiers 2011 (GSP 211)*, American Society of Civil Engineers, Dallas, TX, 4563-4572.
- Doyle, J.D. and Howard, I.L. (2016). "Characterization of Dense-Graded Asphalt with the Cantabro Test," *J. Testing and Evaluation*, 44(1), 77-88.
- Howard, I.L., Doyle, J.D., and Cox, B.C. (2013). "Merits of Reclaimed Asphalt Pavement-Dominated Warm Mixed Flexible Pavement Base Layers," *Road Materials and Pavement Design*, Special Issues from 88th Association of Asphalt Paving Technologists' Annual Meeting, 14 (S2), 106-128.
- Howard, I.L. and Doyle, J.D. (2015). "Durability Indices via Cantabro Testing for Unaged, Laboratory Conditioned, and One Year Outdoor Aged Asphalt Concrete," *Proc. 94th Annual Meeting of the Trans. Research Board*, Paper 15-1366.

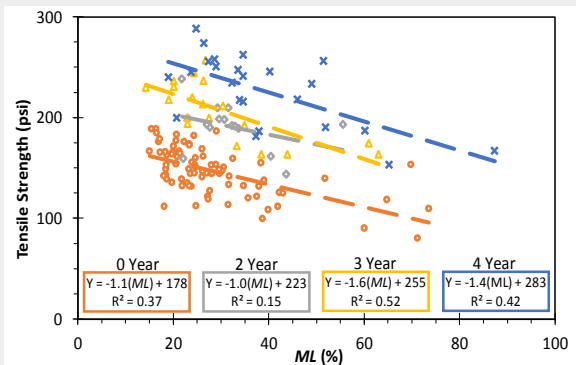


Test Section Moisture Damage Resistance

- Hamburg testing shows no stripping
- No inflection point and rut depths of 6 mm or less



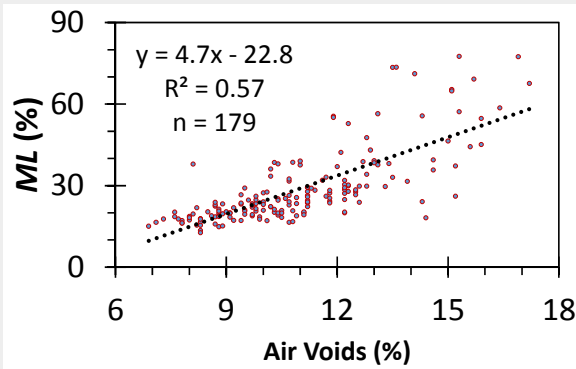
25°C IDT (S_t) vs Cantabro (ML) - Cores



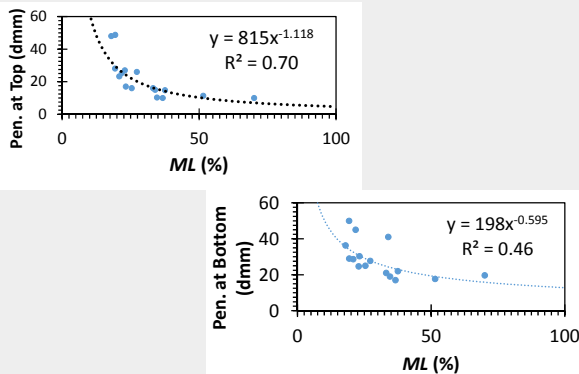
Cantabro (ML) vs 25°C IDT (S_t)

- IDT and Cantabro both increased over time
- IDT changed less than Cantabro over time
- IDT and Cantabro were expected to correlate reasonably well when no moisture damage is present, and that generally appears to have happened

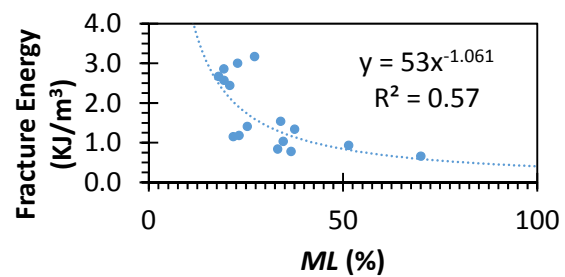
Test Section Cantabro vs Air Voids



Test Section Cantabro vs Binder Penetration



Test Section Cantabro vs Fracture Energy




Note that for GTR Modified Specimens that Were Gyrotory Compacted, Relationship was Different
 $ML(\%) = -2.45 (FE_{20C}) + 13.9$ R^2 of 0.79

Another Aging Experiment

(Airfield Mixes – Gyratory Compacted)

--Fine graded mixes
--Lots of additional data is collected and forthcoming, not shown for brevity



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Summary (Presenter's Opinion)

1. We need to evaluate mix tests relative to whether or not they can help us produce better mixes now
2. We need to stop hoping for the perfect good, fast, and cheap test, and use what we have, even if it is only a little better than what we have now
3. We can improve on mix testing over time, but trying some of this during production should help provide more understanding of what to do w/ time
4. The more data we collect on the Cantabro test for dense graded asphalt, the more promising it looks

Questions?



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