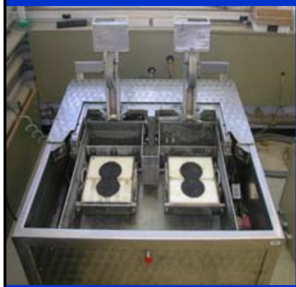
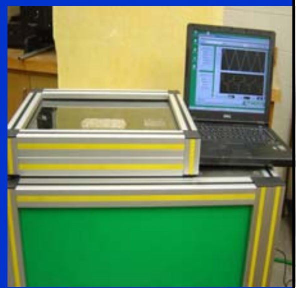
Update on the Texas Overlay Tester

Tom Scullion TTI



Hamburg Wheel Tracking Device



Overlay Tester

Presentation Overview

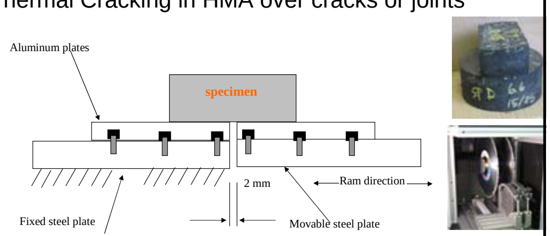
- Background
  - Initial Validation Studies
  - RBL development in Houston
- Current Implementation Status
  - Tex Method 248 Test protocol
  - SS 3055 Crack Attenuating Mixes
- Research Applications Underway
  - APT validation testing
  - Balanced Mix design
  - RAP mixes (when to change binder grade)
  - Very thin Overlays
  - Basis of ME overlay design program
- Challenges to Further Implementation
  - Test repeatability
  - Where/when and how to apply

Overlay Tester Background

- **Concept over 40 years old**
- **Early work at Texas A&M and Europe**
- **Used extensively in 1980's to study inter-layers and fabrics**
- **TxDOT study (2001) used to investigate failures**

Overlay Tester Concept

Thermal Cracking in HMA over cracks or joints

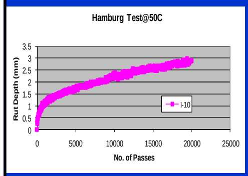


Test Temperature	77F	Lab design Air Voids	7%
Opening displacement	0.025 inches	Test time	3 hours max
Design Parameter	# cycles to failure	Stiffness	load on 1st cycle

Field Validation Studies

Overlays over cracked pavements

IH-10 Type C (PG76-22L), 4.4%AC



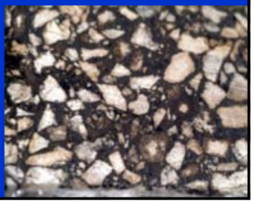
Properties	Result	Target
Cracking (overlay tester cycles to failure)	2	>300
Rutting Hamburg (Hamburg cycles to 0.5 inch rut)	>20K	>20K

Rut resistance mix (4 in thick) placed on IH 10 in 2002 very heavy traffic

Severe reflection cracking in 2004

What Makes a Poor performing Mix?

- Poor aggregates
  - Soft (crushing)
  - Porous (absorptive)
- Low AC content
- Stiff binders



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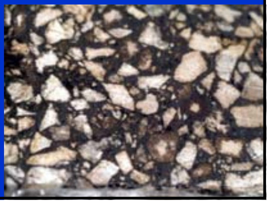


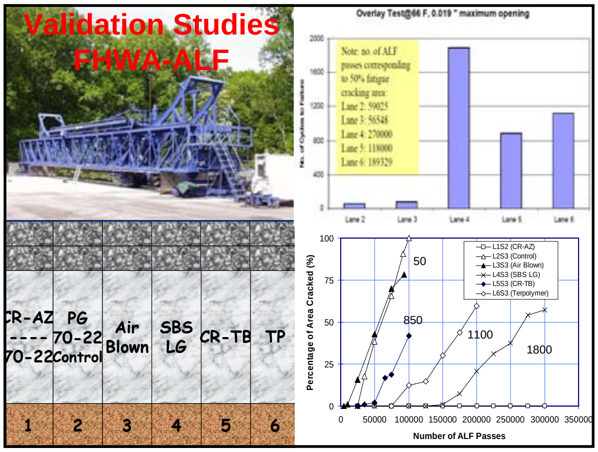
Houston's Superfine SuperPave

(Designed under TxDOT Item 344 SP D – RBL)

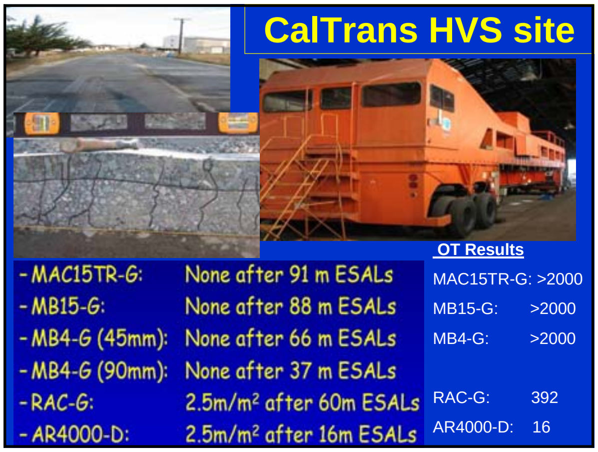
- Screenings Mix Type F approx (40%) and Screenings (60%) (no natural sand) **Class A aggregates recommended**
  - Sieve — % Passing
    - 3/8 — 100
    - #4 — 90 min
    - #10 — 55 min
    - #40min — 20 min
    - #200 — 8 max
- Target AC content 7.0 to 8.0%
- Designed as Rich Bottom Layer
- Target lab density 98% at Ndes = 50 gyrations
- Pass Overlay tester Minimum 750 cycles
- Pass Hamburg criteria for PG Grade

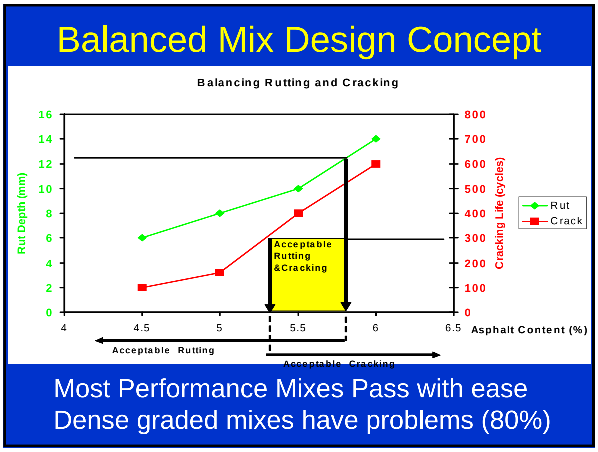
Research recently completed or underway with the Overlay Tester

- 4 TxDOT labs + 1 Commercial lab + TTI in Texas
- New Jersey (Rutgers), Pennsylvania, NCAT, Reno (Univ Nevada), Road Science

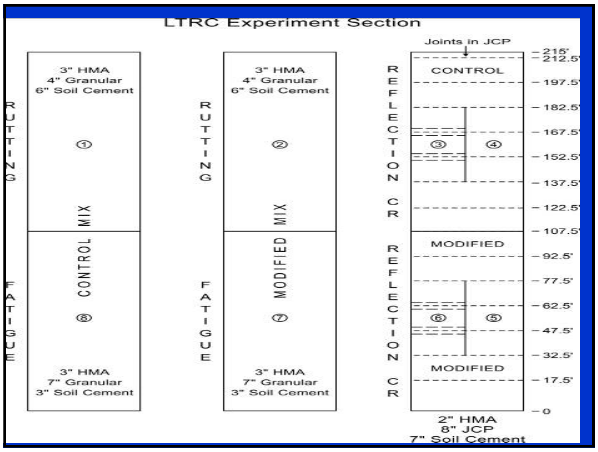

Validation Studies
FHWA-ALF
Overlay Test@66 F, 0.019 " maximum opening
Note: no. of ALF passes corresponding to 50% fatigue cracking area:
Lane 2: 59025
Lane 3: 56548
Lane 4: 270000
Lane 5: 118000
Lane 6: 189329
No. of Cycles to Failure
Lane 2
Lane 3
Lane 4
Lane 5
Lane 6
CR-AZ

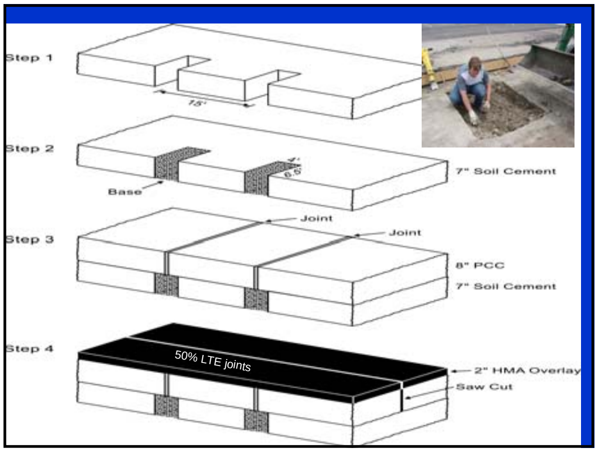
70-22
PG
70-22
Control
Air
Blown
SBS
LG
CR-TB
TP
1
2
3
4
5
6
L1S2 (CR-AZ)
L2S3 (Control)
L3S3 (Air Blown)
L4S3 (SBS LG)
L5S3 (CR-TB)
L6S3 (Terpolymer)
50
850
1100
1800
Percentage of Area Cracked (%)
Number of ALF Passes


CalTrans HVS site
OT Results
-MAC15TR-G: None after 91 m ESALs
-MB15-G: None after 88 m ESALs
-MB4-G (45mm): None after 66 m ESALs
-MB4-G (90mm): None after 37 m ESALs
-RAC-G: 2.5m/m² after 60m ESALs
-AR4000-D: 2.5m/m² after 16m ESALs
MAC15TR-G: >2000
MB15-G: >2000
MB4-G: >2000
RAC-G: 392
AR4000-D: 16

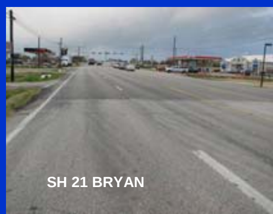

Balanced Mix Design Concept
Balancing Rutting and Cracking
Rut Depth (mm)
Cracking Life (cycles)
Acceptable Rutting &Cracking
Rut
Crack
Asphalt Content (%)
Acceptable Rutting
Acceptable Cracking
Most Performance Mixes Pass with ease
Dense graded mixes have problems (80%)

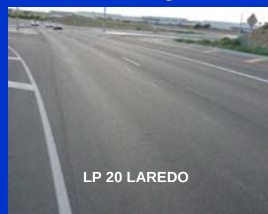

APT Testing at LTRC
Dense Graded Mix Evaluation


LTRC Experiment Section
Joints in JCP
3" HMA
4" Granular
6" Soil Cement
RUTTING
CONTROL MIX
FATIGUE
3" HMA
7" Granular
3" Soil Cement
MODIFIED MIX
CONTROL
REFLECTION CR
MODIFIED
2" HMA
8" JCP
7" Soil Cement


Step 1
Step 2
Step 3
Step 4
7" Soil Cement
Base
Joint
8" PCC
50% LTE joints
2" HMA Overlay
Saw Cut

CAM as 1 inch overlay





- 100% passing 3/8 inch sieve
- High quality Rock
- AC content 7 to 8.5% as separate bid item
- Pass HWTT and OT (750 cycles)
- Some issues with high impact areas (corners) and skid
- Rethink mix design (currently 50 gyrations at 98% density)

CAM in maintenance operations

Amarillo RAP test sections

RAP improves rutting test results makes cracking results worse

Experimental test sections on IH40:

- 0% RAP section: Control section
- **20% RAP section: TTI designed**
- **35% RAP section: TTI designed**

IH 40 RAP Test sections

Summer 2009

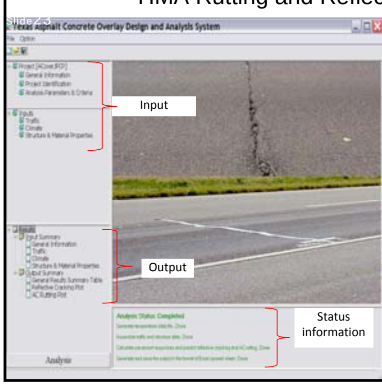
Type C Texas Gyratory Design

Fractionated RAP

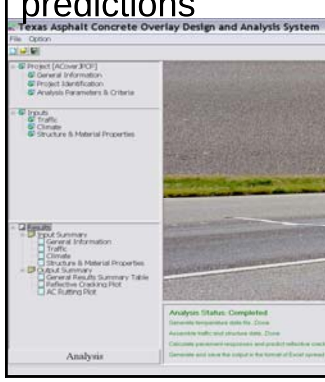
RAP	AC	Grade	HWTT	OT
%	%		mm	cycles
0	5.3	64-22	8.7	510
20	5.3	64-28	6.9	140
35	5.5	58-28	8.0	220

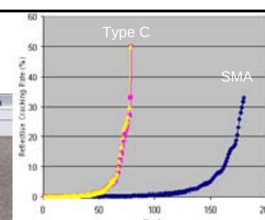
M E Overlay Design program

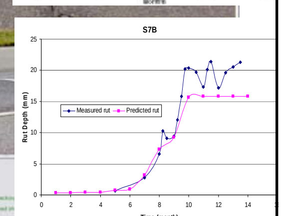
HMA Rutting and Reflection Cracking



Rutting/Cracking predictions

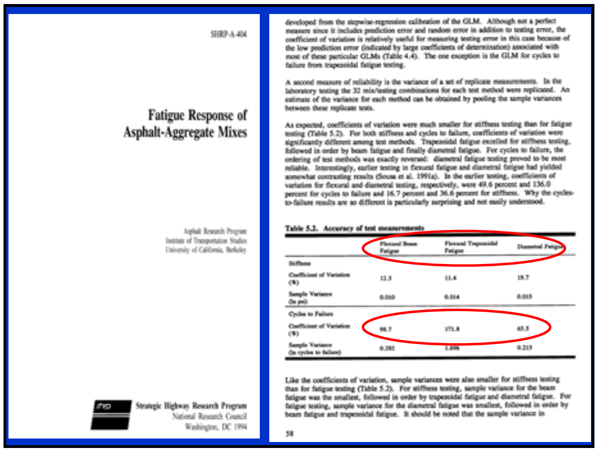






Challenges to Implementation

- Repeatability
  - Round robin testing
- Where, when and how to apply cracking criteria
  - Which mixes (surface, base)
  - Which projects (cracked, non cracked)
  - What criteria



SHRP-A-404

Fatigue Response of Asphalt-Aggregate Mixes

Asphalt Research Program
Institute of Transportation Studies
University of California, Berkeley

Strategic Highway Research Program
National Research Council
Washington, DC 1994

developed from the stepwise-regression calibration of the GLM. Although not a perfect measure since it includes prediction error and random error in addition to testing error, the coefficient of variation is relatively useful for measuring testing error in this case because of the low prediction error (indicated by large coefficients of determination) associated with most of these particular GLMs (Table 4.4). The one exception is the GLM for cycles to failure from trapezoidal fatigue testing.

A second measure of reliability is the variance of a set of replicate measurements. In the laboratory testing the 32 mix/testing combinations for each test method were replicated. An estimate of the variance for each method can be obtained by pooling the sample variances between these replicate tests.

As expected, coefficients of variation were much smaller for stiffness testing than for fatigue testing (Table 5.2). For both stiffness and cycles to failure, coefficients of variation were significantly different among test methods. Trapezoidal fatigue excelled for stiffness testing, followed in order by beam fatigue and finally diametral fatigue. For cycles to failure, the ordering of test methods was exactly reversed: diametral fatigue testing proved to be most reliable. Interestingly, earlier testing in flexural fatigue and diametral fatigue had yielded somewhat contrasting results (Sousa et al. 1991a). In the earlier testing, coefficients of variation for flexural and diametral testing, respectively, were 49.6 percent and 136.0 percent for cycles to failure and 16.7 percent and 36.6 percent for stiffness. Why the cycles-to-failure results are so different is particularly surprising and not easily understood.

Table 5.2. Accuracy of test measurements

	Flexural Beam Fatigue	Flexural Trapezoidal Fatigue	Diametral Fatigue
Stiffness			
Coefficient of Variation (%)	12.3	11.4	19.7
Sample Variance (ln psi)	0.010	0.014	0.015
Cycles to Failure			
Coefficient of Variation (%)	98.7	171.8	65.5
Sample Variance (ln cycles to failure)	0.282	1.096	0.213

Like the coefficients of variation, sample variances were also smaller for stiffness testing than for fatigue testing (Table 5.2). For stiffness testing, sample variance for the beam fatigue was the smallest, followed in order by trapezoidal fatigue and diametral fatigue. For fatigue testing, sample variance for the diametral fatigue was smallest, followed in order by beam fatigue and trapezoidal fatigue. It should be noted that the sample variance in

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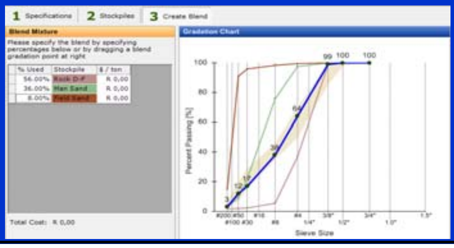
Repeatability and Round-Robin Test -conducted by Lubinda Walubita

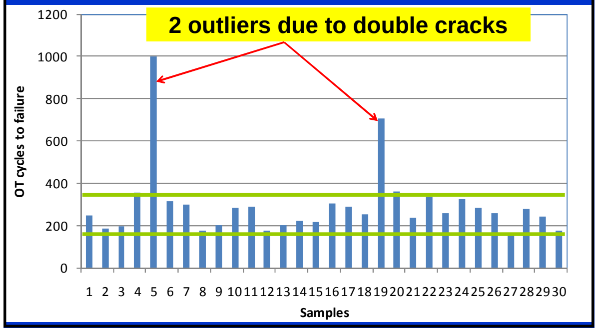
Mix type: Type D (Recommended by CST)

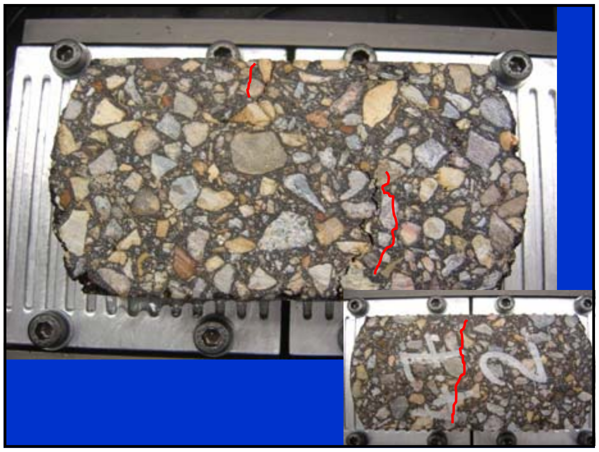
Binder: 5% PG 70-22 (Valero)

Aggregate: Limestone (Chico)

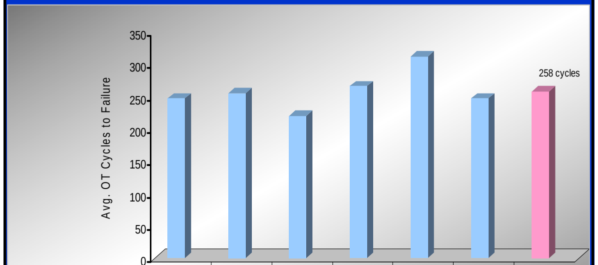


Overall Results: 6 labs a total of 30 samples





Results from 6 OT machines in Texas (3 Districts, CST, TTI and PaveTex)



	Lab# 1	Lab# 2	Lab# 3	Lab# 4	Lab# 5	Lab# 6	Overall Avg.
Avg. OT Cycles (Single Crack)	247	255	220	266	312	247	258
COV	31.4%	24.4%	22.0%	15.3%	21.0%	22.6%	22.8%

Status Report on OT

- Round Robin complete; COV 23%(reasonable)
  - Found need for equipment calibration
  - Need to improve for technician training
  - Revised test protocol
    - Standardize sample prep
- Developed video of procedure complete
  - Step by step
- More round robin studies proposed

Bottom Line

- **IF** reflection cracking or fatigue cracking is a concern the overlay tester can be used to design better performing mixes (300 cycles is good for surface mixes on cracked pavements)
- SMA's and other performance mixes have no problem passing these criteria
- Many TxDOT dense graded mixes do not last more than 50 cycles
- No criteria for base mixes
- Performance strongly related to quality of aggregates and % binder used

More Information on Overlay Tester

http://dmgdemo.tamu.edu/overlay-test/

www.shedworks .com

Tex Method 248F   SS 3155

Overlay Design system   f-zhou@tamu.edu

Other users
Tom Bennett Rutgers
Peter Sebaaly Nevada
NCAT and Road Science LLC

Mix Design   TTI Lab

Checking Aggregate/Binder compatibility

- Different failure mechanisms observed in overlay tester
  - Crack through binder
  - Crack through interface between aggregate and binder
  - Crack through rock

Status Report on OT

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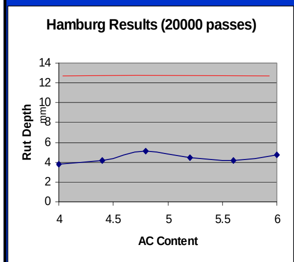
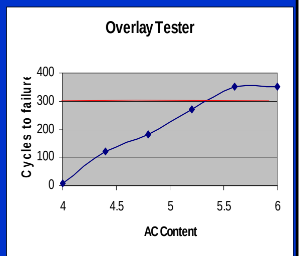
  - Found need for equipment calibration
  - Found need for technician training
  - Revised test protocol
    - Standardize sample prep
- Developed video of procedure complete
  - Step by step
- Need to meet to plan further implementation with CST and all participating labs

FM 529 Type D Experimental Section

Contact: Tony Yrigoyen Houston District

Item 340 spec for Type D Jones Mill + 76-22S binder





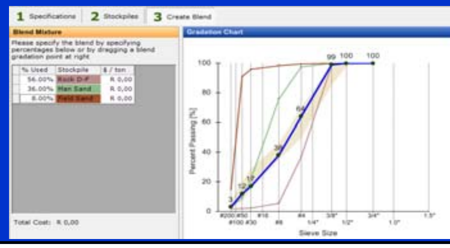
Type D Results

Repeatability and Round-Robin Test

Mix type: Type D (Recommended by CST)

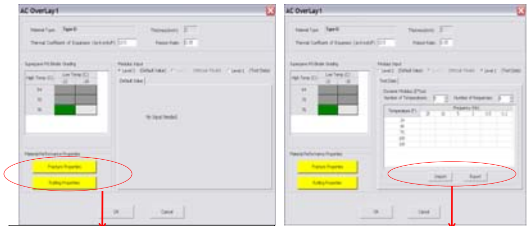
Binder: 5% PG 70-22 (Valero)

Aggregate: Limestone (Chico)



AC material property input

Level 3 Input Level 1 Input



There are default values for the selected Asphalt and aggregate type.

You can import or export dynamic modulus here.