

## 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

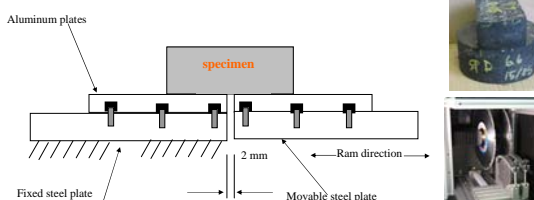
## Overlay Tester Background

- 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

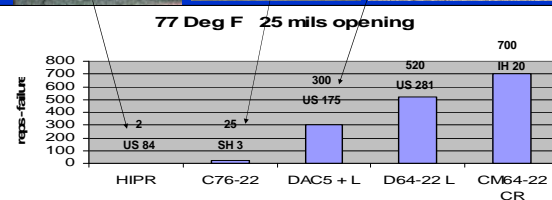
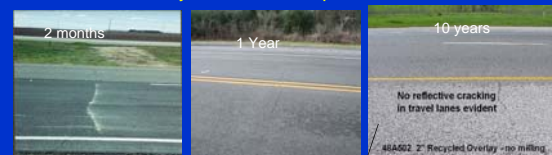
Thermal Cracking in HMA over cracks or joints




|                      |                     |                      |                               |
|----------------------|---------------------|----------------------|-------------------------------|
| 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 1 <sup>st</sup> cycle |

## Field Validation Studies

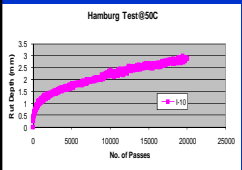
Overlays over cracked pavements



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



| Properties  | Result | Target |
|---|--------|--------|
| Cracking<br><small>(overlay tester cycles to failure)</small>         | 2      | >300   |
| Rutting<br>Hamburg<br><small>(Hamburg cycles to 0.5 inch rut)</small> | >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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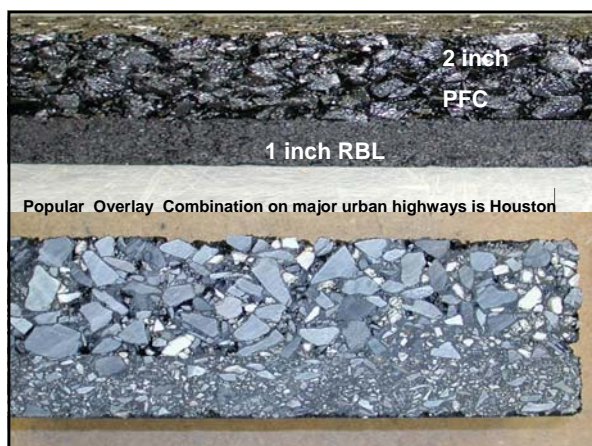
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- ~~Stiff binders~~



### Houston's Superfine SuperPave

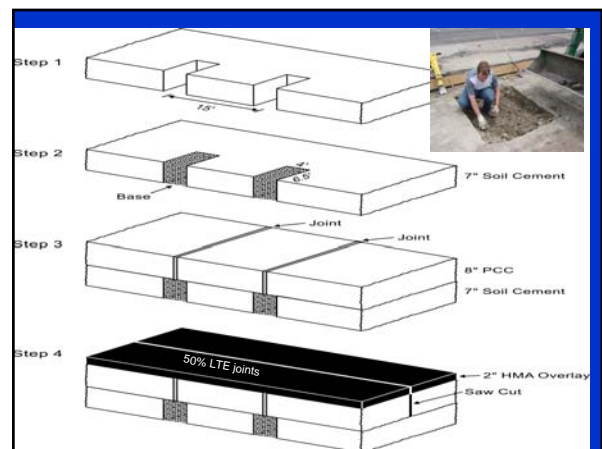
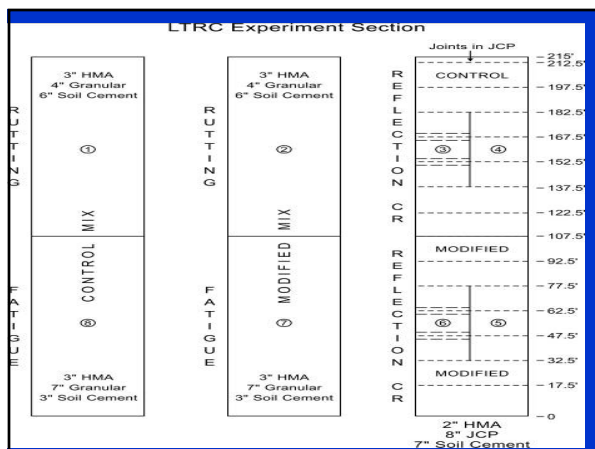
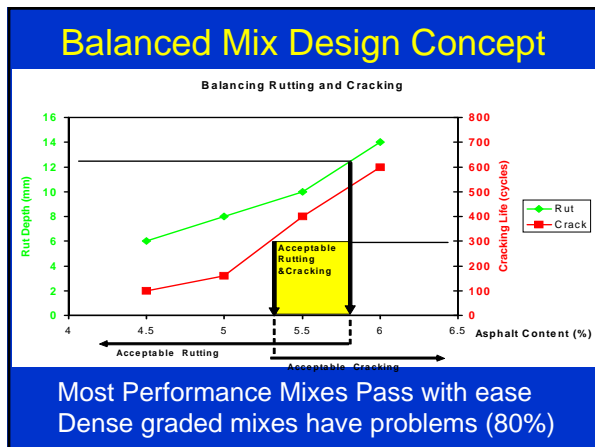
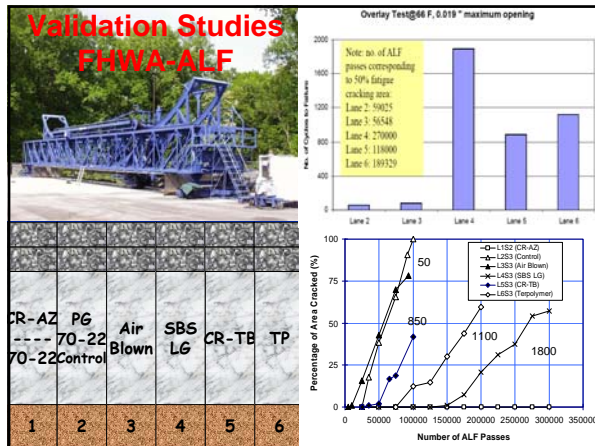
(Designed under TxDOT Item 344 SP D – RBL)

- Screenings Mix Type F approx (40%) and Screenings (60%) (no natural sand) **Class A aggregates recommended**
  - Sieve
  - 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

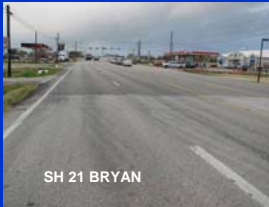



### Research recently completed or underway with the Overlay Tester

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



### 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



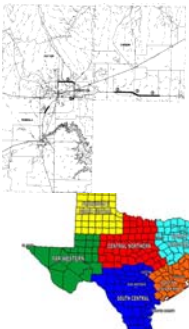


### Amarillo RAP test sections

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**



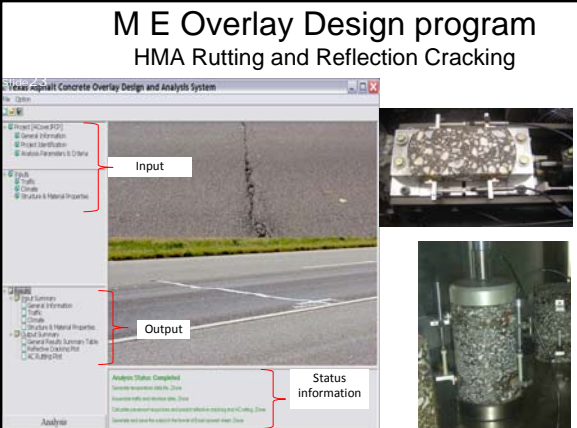
### IH 40 RAP Test sections

Summer 2009  
Type C Texas Gyrotory Design  
Fractionated RAP

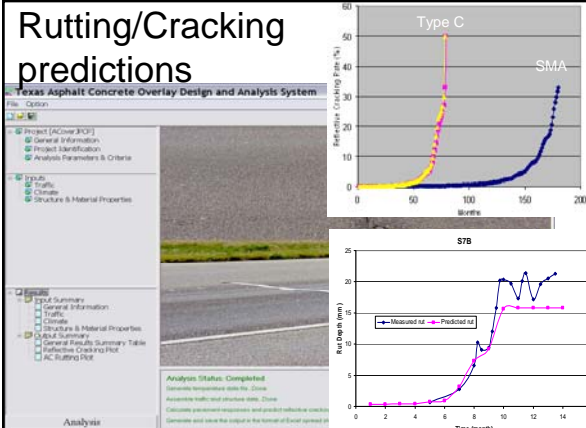



| RAP % | AC % | Grade | HWTT mm | OT cycles |
|-------|------|-------|---------|-----------|
| 0     | 5.3  | 64-22 | 8.7     | 510       |
| 20    | 5.3  | 64-28 | 6.9     | 140       |
| 35    | 5.5  | 58-28 | 8.0     | 220       |

### 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

SIRP-A-614

### Fatigue Response of Asphalt-Aggregate Mixes

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

developed from the stepwise-regression calibration of the CLM. 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 CLMs (Table 4.4). The one exception in the CLM the cycles to failure from transverse 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. Transverse fatigue resulted for stiffness testing, followed in order by beam fatigue and finally diamond fatigue. For cycles to failure, the ordering of test methods was exactly reversed: diamond fatigue testing proved to be most reliable. Interestingly, earlier testing in flexural fatigue and diamond fatigue had yielded somewhat contrasting results (Clausen et al., 1992a). In the earlier testing, coefficients of variation for flexural and diamond 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.

|  | Percent Beam Fatigue | Percent Transverse Fatigue | Diamond Fatigue |
|--|----------------------|----------------------------|-----------------|
| Stiffness                              |                      |                            |                 |
| Coefficient of Variation (%)           | 12.3                 | 11.4                       | 15.7            |
| Sample Variance (in MPa)               | 0.009                | 0.014                      | 0.003           |
| Cycles to Failure                      |                      |                            |                 |
| Coefficient of Variation (%)           | 16.7                 | 171.8                      | 45.5            |
| Sample Variance (in cycles to failure) | 0.287                | 1.288                      | 0.217           |

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 transverse fatigue and diamond fatigue. For fatigue testing, sample variance for the diamond fatigue was smallest, followed in order by beam fatigue and transverse fatigue. It should be noted that the sample variance in

Strategic Highway Research Program  
National Research Council  
Washington, DC 1994

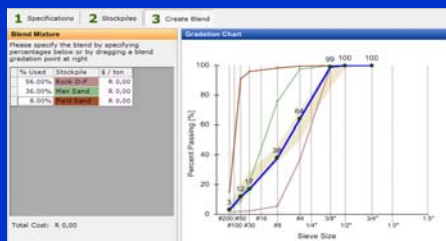
## Repeatability and Round-Robin Test

-conducted by Lubinda Walubita

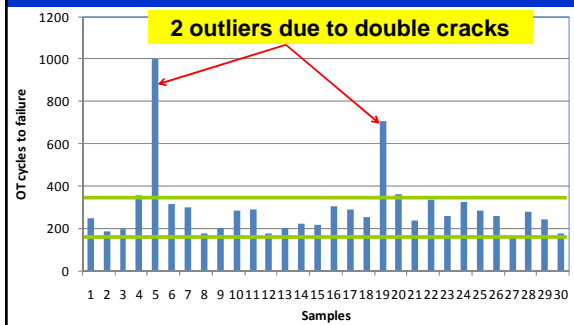
Mix type: Type D (Recommended by CST)

Binder: 5% PG 70-22 (Valero)

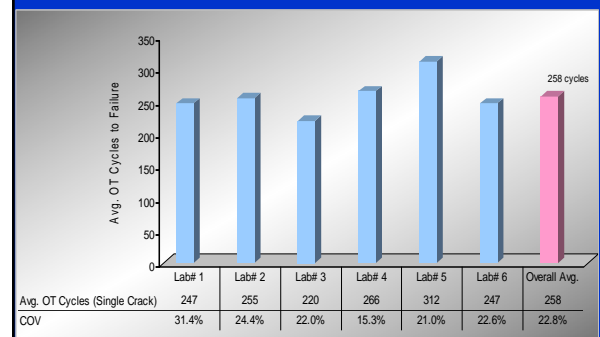
Aggregate: Limestone (Chico)



## Overall Results: 6 labs a total of 30 samples



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



### 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](http://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

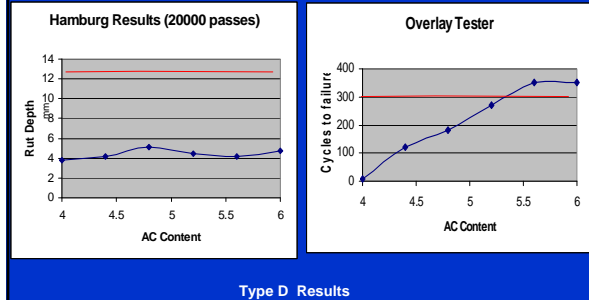


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- Round Robin complete; COV 23%(reasonable)
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  - Step by step
- Need to meet to plan further implementation with CST and all participating labs

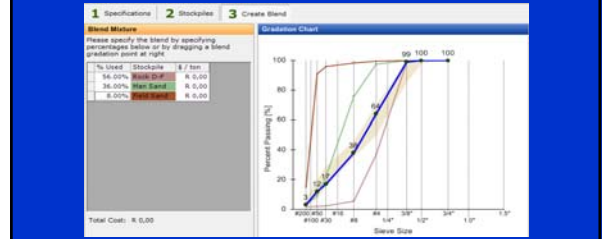
**FM 529 Type D Experimental Section**

Contact: Tony Yrigoyen Houston District  
 Item 340 spec for Type D Jones Mill + 76-22S binder



**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

**Level 3 Input**

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

**Level 1 Input**

You can import or export dynamic modulus here.

