Thin Overlays (1 inch thick or less) Research Projects 0-6743 and 5598-03

Texas A&M Transportation Institute
Texas Department of Transportation

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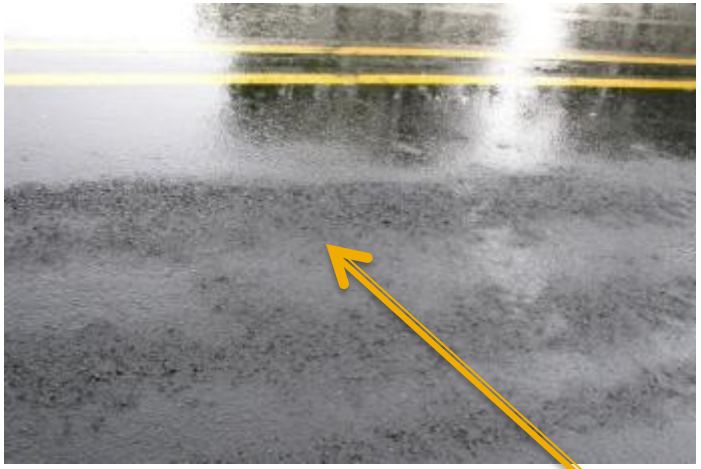
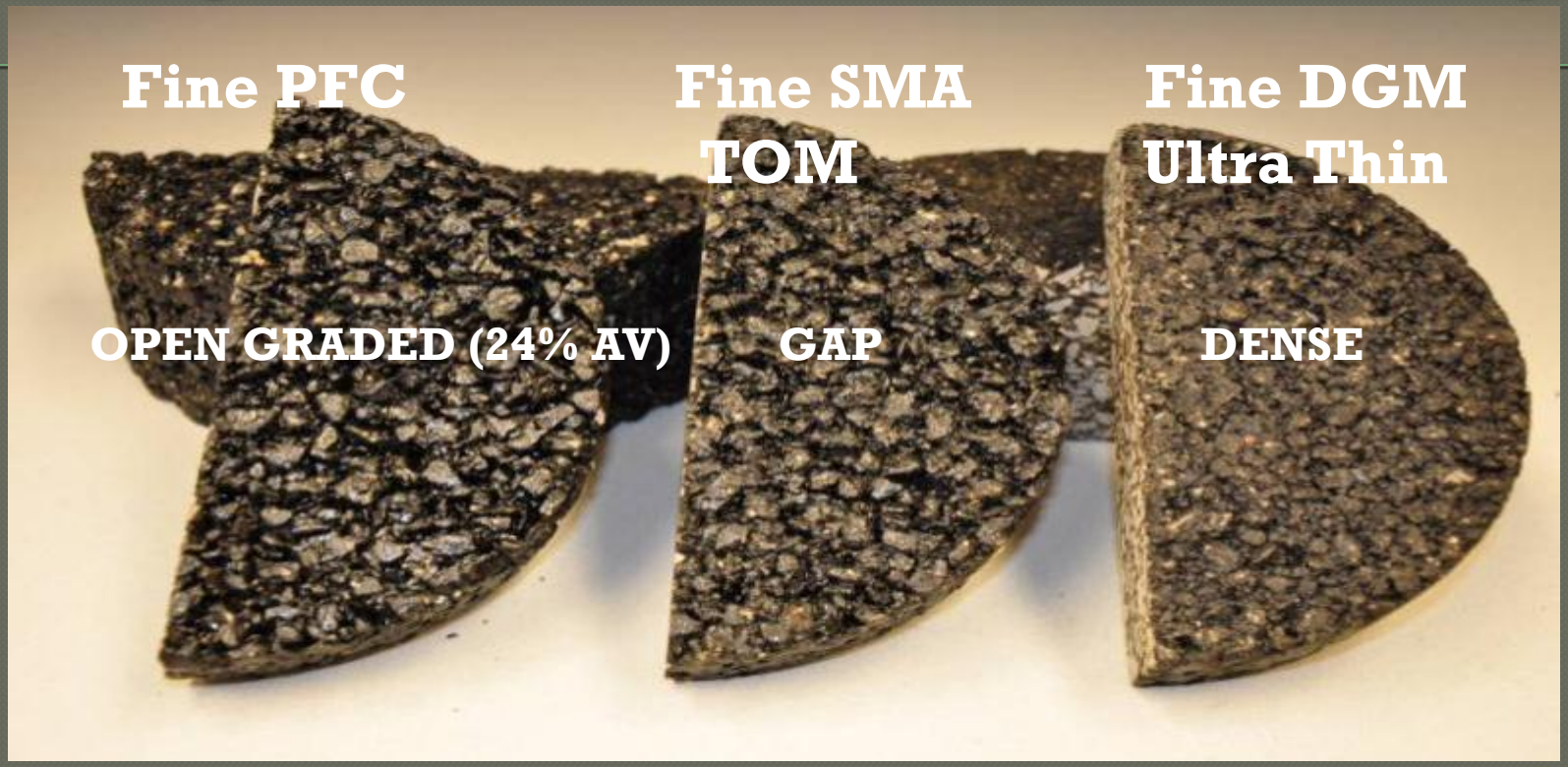
Recent Problems with Dense mixes (Austin District)

- Dense Graded Overlay Issues:
  - Issues with raveling and failures due to segregation and low AC
  - Fatigue & Top Down Cracking
    - Due to premature aging and/or low AC
    - Overly stiff mixtures due to recycled asphalt materials



2 years old overlay with RAP/RAS

High Performance Thin Overlays



- 30% Cost savings over traditional mixes - lifts of 1 inch or less
- Pass Rutting (HWTT) and Cracking (OT) performance tests
- Min 6% PG 76-22 SAC A Rock, 100% passing 3/8" NO RAP or RAS
- Already added to TxDOT's new 2013 Statewide Specs
- Structurally sound pavements ONLY

Overview of Presentation

1. Review of existing TxDOT specifications for thin overlays
2. Laboratory Design Performance Tests
3. From Research Test Sections to Full Implementation
4. Austin District's TOM projects
5. Cost Savings
6. Continuing Research Studies

http://www.dot.state.tx.us/business/specifications.htm

Existing Specs

SPECIAL SPECIFICATION

3228

Fine Surface Mixes (Volumeteric Design Method)

1. **Description.** Construct a fine graded surface mix composed of a compacted mixture of aggregate and asphalt binder mixed hot in a mixing plant and placed at a lift thickness of 1 inch or less. Fine surface mixtures are defined as either

   Type I fine permeable friction course (F-PFC),

   Type II fine- stone matrix asphalt (F-SMA), or

2004 Specifications Austin, Paris, & San Angelo Districts

ITEM 347

Thin Surface Mixtures (TSM)

1. **Description.** Construct a thin surface course with a mixture composed of a compacted mixture of aggregate and asphalt binder mixed hot in a mixing plant and placed at a lif thickness of 1/2 to 1-1/4 inch depending on the thin mixture type specified. Thin surface mixtures are defined as either:

   Type I, thin overlay mixture (TOM),

   Type II, fine-graded stone matrix asphalt (FGSMA), or

   Type III, ultra-thin mixture (UT)

SPECIAL SPECIFICATION

3239

Thin Overlay Mixture (TOM)

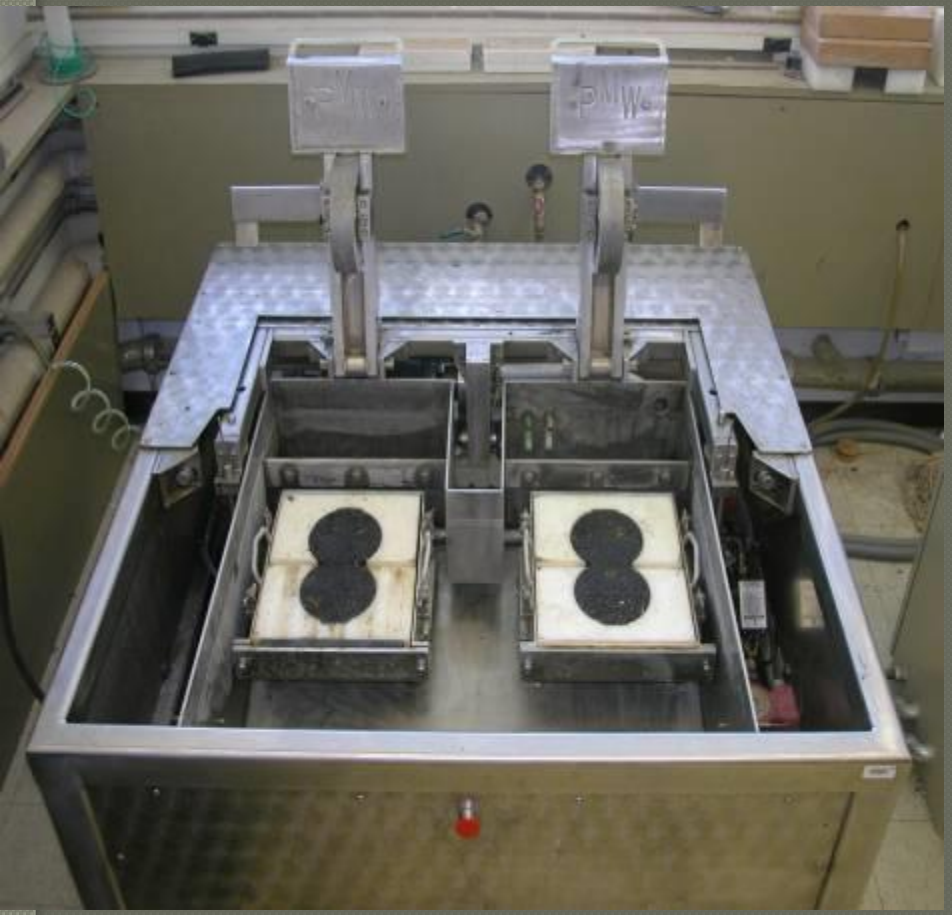
1. **Description.** Construct a thin friction course overlay surface mix composed of a compacted mixture of aggregate and asphalt binder mixed hot in a mixing plant and placed at a lift thickness of 3/4 to 1-1/4 inch.

Table 6
Laboratory Mixture Design Properties

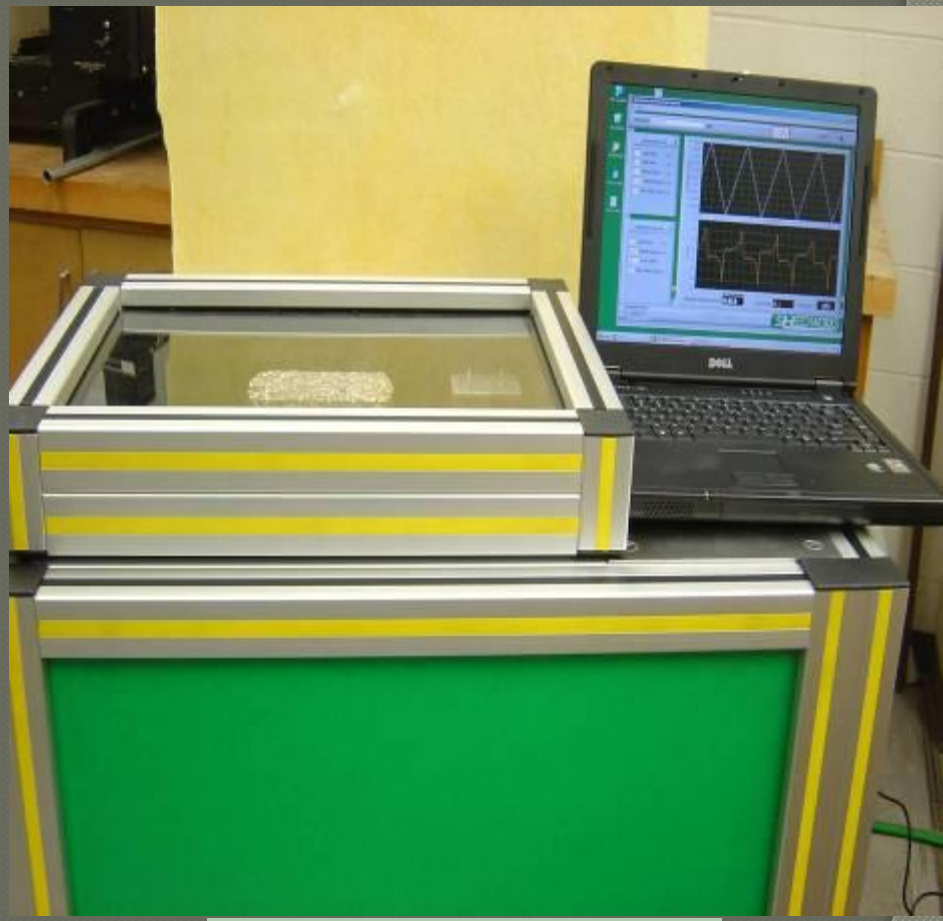
Property	Requirement		
	I Fine- PFC	II Fine- SMA	III Fine- DGM
Design Gyrations (Tex-241-F)	50	Texas Gyratory Compactor	50[1]
Lab Molded Density Tex 207 F	72[2] – 76	96.5	96.5
Hamburg Wheel Tracking Test[3] Tex 242-F	Min 10,000 passes	Min 20,000 passes	Min 20,000 passes
Overlay Tester (Min. # Cycles) Tex 248-F[3]	300	300	300
Tensile Strength (dry), psi Tex-226-F	NA	85-200[6]	85-200[6]
Fiber Content %[5] (min – max)	0.2 – 0.5	0.2 - 0.5	NA[4]
Lime Content % (max)	1.0	1.0	1.0
Drain Down test % Tex 235 - F	Max 0.20%	Max 0.20%	NA
Cantabro Loss % Tex 245 - F	Max 20%	NA	NA

1.May be adjusted in the range of 50 to 100 gyrations when shown on the plans or allowed by the Engineer
2.Suggested test limit. Test and report for informational purposes only
3.For Performance testing Type I mixes compacted to lab molded density used to select Optimum Asphalt Content from Tex 207 F (in range 72 – 76%), Type II and III molded to 93%+/- 1% as per Tex 242-F and 248-F.
4.Not applicable.
5.Calculated by weight of total mixture.
6.May exceed 200 psi when approved and may be waived when approved.

Section 2 Designing Thin Overlays
TxDOT's Performance Tests



Hamburg Wheel Tracking Device

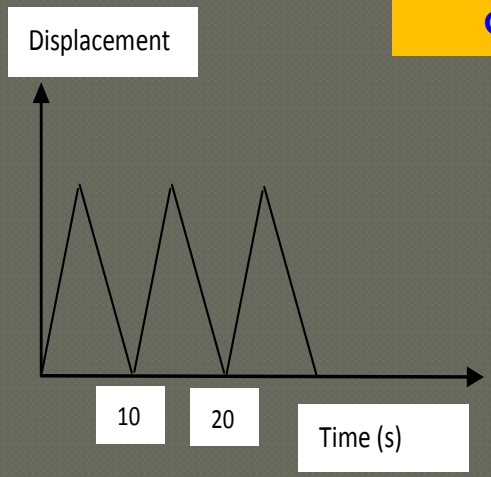


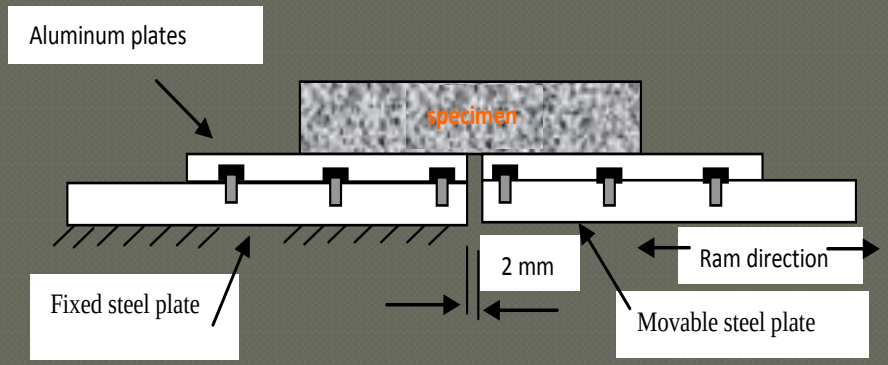
Overlay Tester

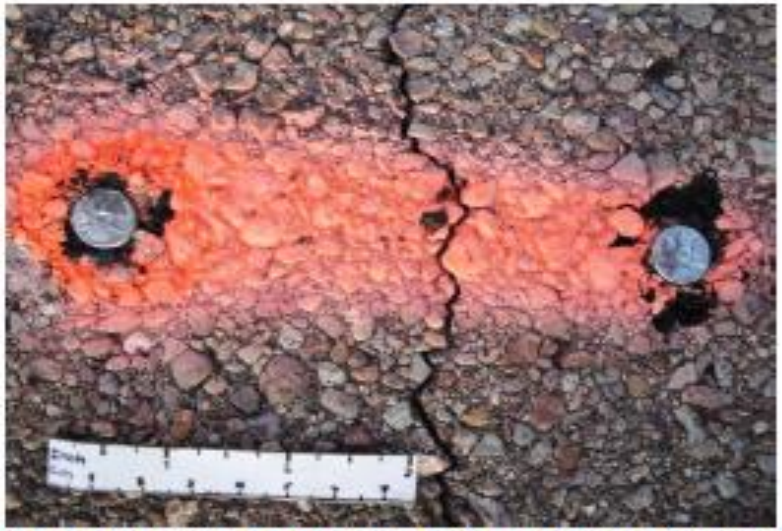
The Texas Overlay Tester (OT)

- Room temp 25 C
- 0.025 inch (0.635 mm)
- 10 s/cycle
- In Texas OT ≥ 300, TOM 500 cycles @ 93% density

Measures load, number of cycles, time, etc

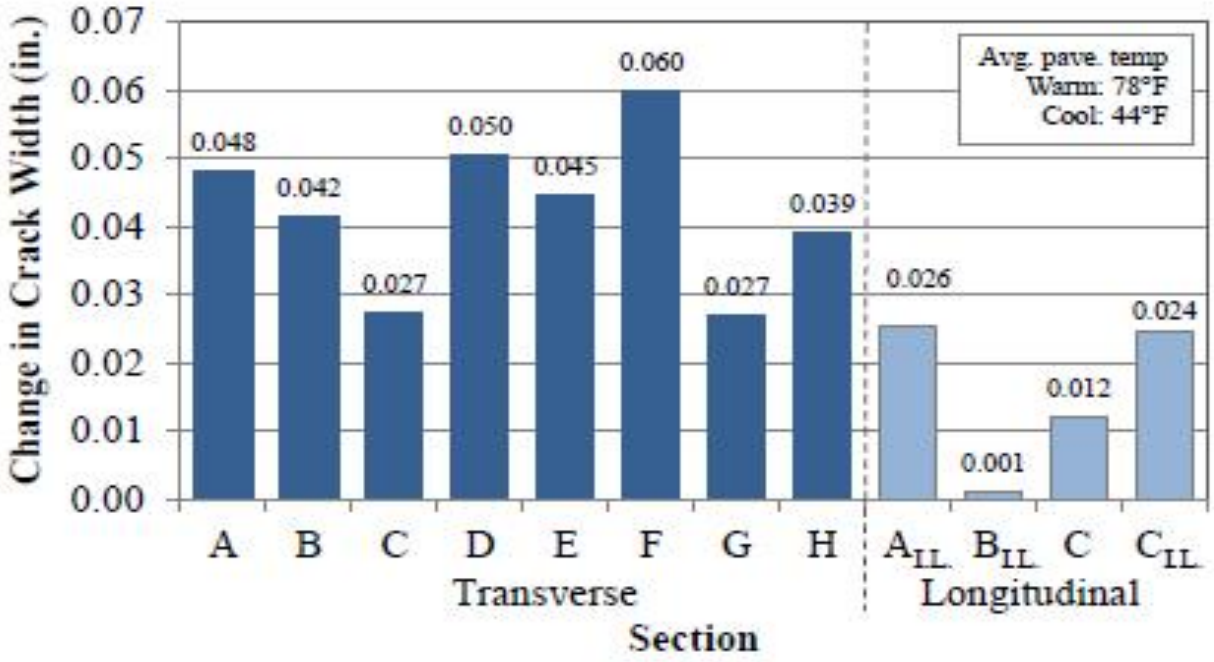






(a) Transverse Crack (b) Reference Nails for Crack Measurements

Figure 8. Method for Measuring Crack Widths.



3. From Research Test Sections to Full Implementation

Research Project 5598-03

Maintenance Div. funding for test sections

Typical Design and Construction Sequence

- Aggregate Selection
- Lab Design Phase
  - Volumetric Design to get OAC
  - Performance testing HWTT + OT + Others
  - Testing at 2 Asphalt Contents (LMD 96.5 and 97.5)
- Trial Batch Testing
- Test Section Construction (1000 ft)
- Construction Monitoring
- Performance Evaluation + Reporting

District Participating in 5598-3

- Districts with sections constructed
  - Lufkin (2 fine PFC)
  - Bryan (1 Fine SMA, 1 Fine PFC)
  - Austin (UT Mix)
  - Brownwood (fine PFC)
- Districts planning first sections
  - TOM San Antonio, Houston, Beaumont
  - Fine PFC San Antonio
  - UT Mix Atlanta, Brownwood

New Rice Crispy PFC

New Fine PFC

Current Item 342

Field Test – Lufkin District – May 2011

After 18 months

July 2012 Full Scale Project Brownwood

- Full scale project US 183, Brownwood, to correct bleeding surface trt.
- 8.75 miles, 5000 tons, $97/ton (Zack Burkett), CSJ 6231-69-001

Sept 2012

Cost ~ $3.50 sy yd

Aug 2012, FG SMA on SH 6 FR Bryan District

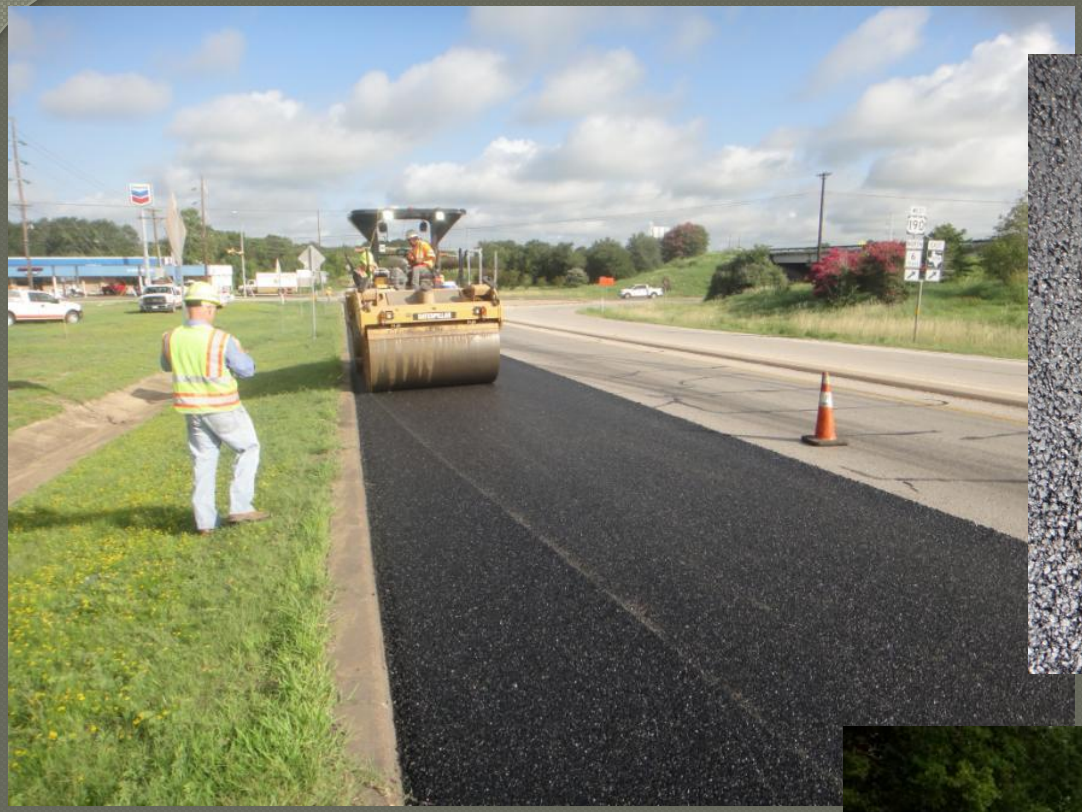
Bryan FG SMA Trial Batch

HAMBURG RESULTS

3.8 mm @ 20,000 cycles

OVERLAY RESULTS

508 Cycles



Austin District TOM Applications Test Section 1: Hot Mix Plant Entry

- Truck Loading (May 2009 to August 2011)
  - Practically 100% Heavy Trucks (Haul trucks & Transports)
  - >3.0 million total tonnage (material and trucks) shipped in and out since overlay
  - Mike Arellano and Tommy Blackmore

Test Section 2: IH-35 Frontage Rd. (From Woodward to Oltorf)

- Skid Number = mid 40's
- Improved Ride
  - Ride Score FY 09 = 3.0
  - Ride Score FY 10 = 4.1
  - Ride Score FY 11 = 4.0
- Added Bonus: Quiet Ride Properties
  - Avg.= 94-98 dBA
  - PFC ~ 98 dBA

Results – Good Performance

- Rut/Crack resistance
- Skid resistance
  - SAC B – High 30's to Mid 40's
  - SAC A – High 40's to Low 50's
- IRI improvement
  - Typically 25-35% improvement – depends on pre-existing conditions
- Sound Abatement
  - 2 to 6 times reduction in noise
  - 96.5-98dB = AR-PFC

IH-35 (ADT >100K): BEFORE/AFTER

Austin District
Lessons Learned & Best Practices

- Design and Construction – Best Practices
  - Micro-milling spec under development
  - Use of WMA (compaction aide - long haul distances)
  - Place when ambient temp. 70° F or greater
  - No pneumatics
    - Closes surface - Macrotexture for skid resistance is diminished
    - Cools too quick to take out impressions
    - Rollers should be right behind the paver
  - Similar to PFC - Limits hand work
    - Irregularities shows up more dramatically in thin overlays
  - Project Selection guidelines under development

Ultra Thin HMA
First Jobs in 2013

2012 Ramming Paving
Test section entrance to plant

0.5” UltraThin Mix

Candidate for Ultra Thin Dense Graded Mix (0.5 inches thick)
Restore Texture and fill ruts
Project proposed in

- **Austin (project let)**
- **Atlanta**
- **Brownwood (Bleeding surface)**

Major UT Mix Project
IH 20 Brownwood 4.5 miles long

- Severe stripping problem occurred just after construction with heavy rainfall
- Proposed (Fall 2013)
  - Micro-mill ½ inch in travel lane only
  - Trackless tack
  - ½ inch UT Mix

MIX THICKNESS – EFFECT ON MIX COST

Mix Type	2" Dense Graded Type D	1.5" PFC PFC-C	1.0" PFC PFC-F	2" SMA SMA-D	1" SMA SMA-F
Cost/Ton	$69	$112	$112	$105	$105
Cost/SY	$7.58	$7.56	$5.04	$11.55	$5.77
Cost/Mile	$53,363	$53,222	$35,482	$81,312	$40,621

Austin Results - Economics

3 year Cost Savings with Austin District Thin Overlay Program (Material Cost Only)					
HWY	Traditional Option	CSJ	*Traditional	Thin Overlay Mix (TOM)	Cost Savings
IH-35	1.5 PFC PG 76-22 SAC A	0015-08-131	$7,106,331	$4,856,417	$2,249,914
RM 32	1.5" D-GR HMA TY D	0511-01-016	$527,723	$397,704	$130,019
RM 620	2" D-GR HMA (QCQA) TY-C PG70-22	6222-04-001	$596,565	$347,254	$249,311
SH 130	2" D-GR HMA (QCQA) TY-C PG70-22	6222-00-001	$957,562	$557,387	$400,175
SH 45	2" D-GR HMA (QCQA) TY-C PG70-22	6206-37-001	$660,005	$385,968	$274,037
FM 1431	2" D-GR HMA (QCQA) TY-C PG70-22	1378-03-031	$741,282	$431,492	$309,789
US 87	2" D-GR HMA (QCQA) TY-C PG70-22	0071-06-058	$1,379,391	$802,929	$576,462
FM 3406	2" D-GR HMA (QCQA) TY-C PG70-22	1378-06-012	$490,908	$285,753	$205,156
US 183	2" D-GR HMA (QCQA) TY-C PG70-22	0273-03-026	$616,400	$404,800	$211,600
RM 1431	2" D-GR HMA (QCQA) TY-C PG70-22	1378-02-033	$2,144,000	$1,408,000	$736,000
RM 2244	1.5 PFC PG 76-22 SAC A	2102-01-065	$2,054,455	$1,584,000	$470,455
US 183	2" D-GR HMA (QCQA) TY-C PG70-22	0265-02-033	$2,144,000	$1,408,000	$736,000
LP 360	1.5 PFC PG 76-22 SAC A	0113-13-152	$1,282,500	$968,000	$314,500
SH 95	2" D-GR HMA (QCQA) TY-C PG70-22	0320-03-091	$1,072,000	$704,000	$368,000
FM 685	2" D-GR HMA (QCQA) TY-C PG70-22	0757-02-015	$670,000	$440,000	$230,000
IH-35	2" D-GR HMA (QCQA) TY-C PG70-22	0015-09-165	$1,206,000	$792,000	$414,000
US 183	2" D-GR HMA (QCQA) TY-C PG70-22	0151-05-095	$804,000	$528,000	$276,000
FM 3405	2" D-GR HMA (QCQA) TY-C PG70-22	1755-03-007	$737,000	$484,000	$253,000
SH 71	2" D-GR HMA (QCQA) TY-C PG70-22	0700-04-044	$227,800	$149,600	$78,200
SH 21	2" D-GR HMA (QCQA) TY-C PG70-22	0472-01-037	$1,340,000	$880,000	$460,000
LP 1	2" D-GR HMA (QCQA) TY-C PG70-22	3136-01-168	$709,239	$414,760	$294,479
FM 3177	2" D-GR HMA (QCQA) TY-C PG70-22	3277-01-020	$1,698,002	$992,984	$705,018
SH 71	1.5 PFC PG 76-22 SAC A	0265-02-033	$2,156,144	$1,633,442	$522,702
SH 16	2" D-GR HMA (QCQA) TY-C PG70-22	0289-07-019	$351,788	$205,724	$146,064
SL 275	2" D-GR HMA (QCQA) TY-C PG70-22	0015-11-062	$589,195	$417,713	$171,482
Loop 1	1.5 PFC PG 76-22 SAC A	3136-01-179	$1,080,037	$765,698	$314,339
SH 29	2" D-GR HMA (QCQA) TY-C PG70-22	0151-03-039	$577,941	$409,734	$168,207
FM 734	2" D-GR HMA (QCQA) TY-C PG70-22	6238-10-001	$150,761	$106,883	$43,878
SH 29	2" D-GR HMA (QCQA) TY-C PG70-22	6236-93-001	$665,843	$472,053	$193,790
FM 973	2" D-GR HMA (QCQA) TY-C PG70-22	1200-05-017	$282,470	$200,259	$82,211
US 90	2" D-GR HMA (QCQA) TY-C PG70-22	0029-03-054	$175,229	$124,230	$51,000
FM 734	2" D-GR HMA (QCQA) TY-C PG70-22	3417-01-027	$190,006	$134,706	$55,300
US 183	2" D-GR HMA (QCQA) TY-C PG70-22	0151-04-067	$518,177	$367,365	$150,813
		Total Expense	**$35,902,753**	**$24,060,853**	
		Total Cost Savings	**$11,841,900**		
		Percent Savings	**33%**		

On going Research Study 6742

- Identify Upcoming thin Overlay studies
- Cracking Performance studies
  - Where should criteria be strengthen
- Skid Resistance studies
  - Lab .vs. Field Studies
- Surface Prep Studies
  - Bonding studies
- Compaction Studies
  - Best way of monitoring density of thin lifts

Summary

1. Thin overlays an important role in pavement preservation for structurally sound pavements.
2. TxDOT Specifications have been developed for 3 HMA mixture types
   - **Fine PFC 6.2 to 6.5% Binder**
   - **Fine SMA or TOM 6.5 to 6.8% Binder**
   - **UT Mix 6.7 to 7.3% Binder**
3. Districts have implemented these specifications and field sections are under evaluation
4. Test sections show excellent performance along with skid and noise benefits. No major performance issues have been noted.
5. In 2013 thin overlay specifications to be included in statewide specifications.

Lessons Learned & Best Practices

- Construction – Placement Temperature
  - 1" Thin overlay cools twice the rate of a 1.5" mat
  - What practices have you implemented to address these challenges?
    - Twin Breakdown Rollers
    - Use of WMA

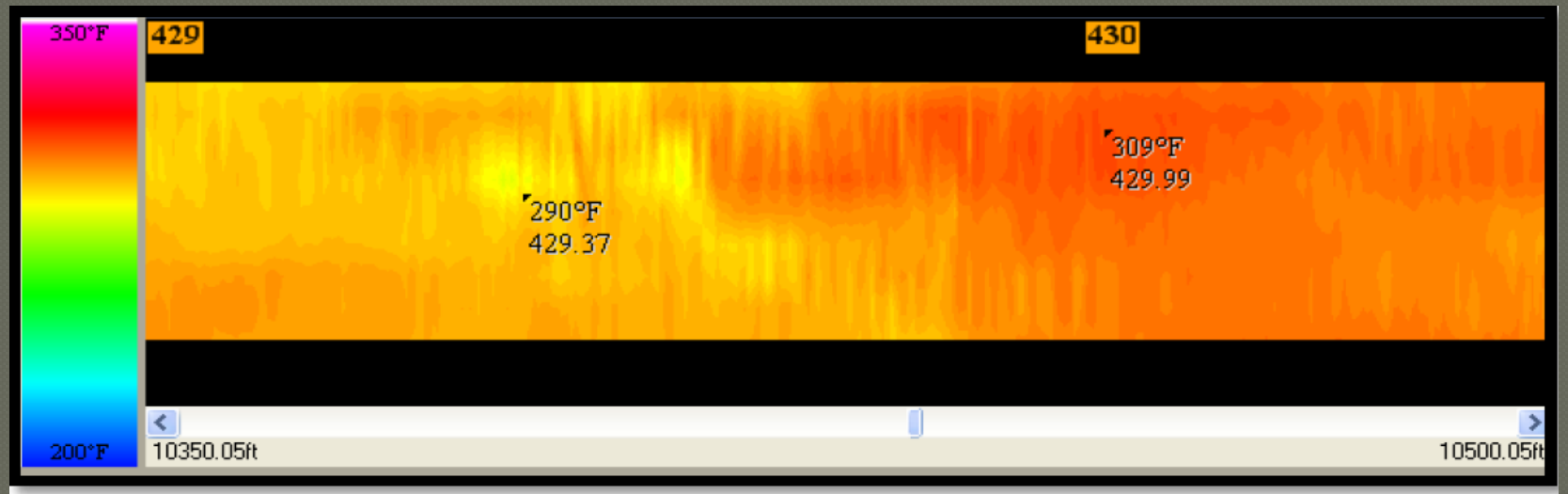
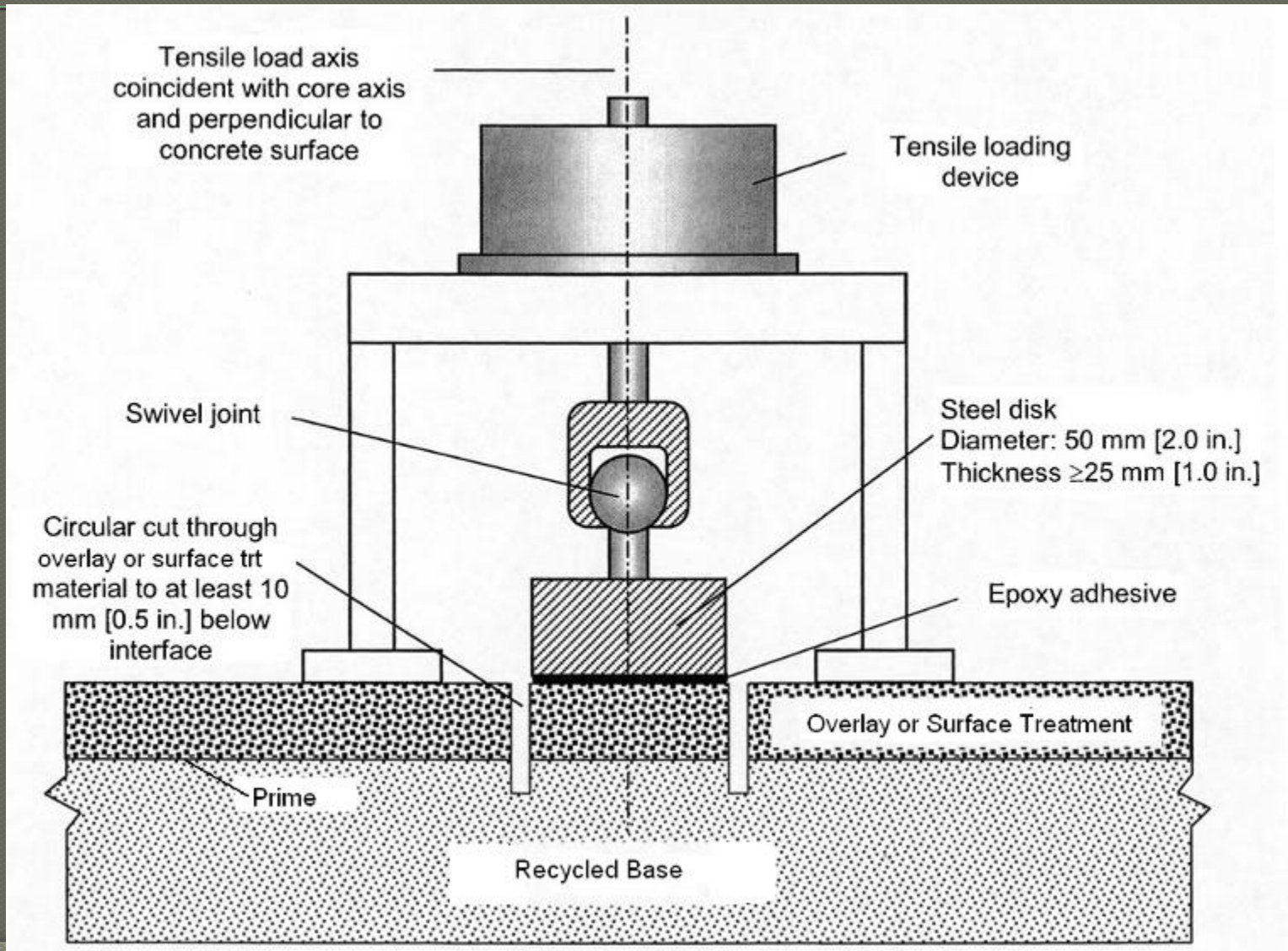


Figure 2. Typical Profile without Thermal Segregation on IH 35 SBIL.

Problems with Tack Coats

Need for Trackless Tack

Direct Tensile Bond Test ASTM C-1583




Z16

Average of 3 Pull-off strengths

	Core II	Core VI
Top Interface (Trackless)	102.5 psi	95.5 psi
Lower Interface	89.3 psi	111.6 psi

Section 3.0
Typical Design and Construction Sequence

- Aggregate Selection
- Lab Design Phase
  - Volumetric Design SGC to get OAC
  - Testing at 2 Asphalt Contents
  - Performance testing HWTT + OT + Others
- Trial Batch Testing
- Construction Monitoring
- Performance Evaluation

Fine Graded PFC

Mill Creek Aggregate (1/4-in chips) used by APAC at Dallas HMA Plants

Fine Graded SMA

65% MILL CREEK ¼ IN CHIPS

35% MILL CREEK DIRTY SCREENINGS

Fine SMA

Mix Design	Percent Passing
3/8 in.	99.7
# 4	65.3
# 8	32.1
# 16	20.9
# 30	14.3
# 50	10.4
# 200	6.6
1% Lime 0.3% Fibers 6.6% PG 76-22	96.5 % Density

Hamburg	Overlay Test
2.66 mm @ 20,000 cycles	**352 cycles**

Fine Dense-Graded Mix

50% MILL CREEK
¼ IN CHIPS

25% MILL CREEK
DIRTY SCREENINGS

25% Mill Creek Clean Screenings

Fine DGM

Mix Design	Percent Passing
3/8 in.	99.8
# 4	73.2
# 8	43.6
# 16	28.3
# 30	17.9
# 50	10.8
# 200	5.4
1% Lime 7.2% PG 76-22	96.5 % Density

Hamburg	Overlay Test
5.4 mm at 20 K	**1000+**