

Technical Memo

Project 0-6132: Task 6 – Test Sections in the Districts

To: Frank Espinosa, Dale Rand, & Ramon J. Rodriguez
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From: Lubinda F. Walubita | CC: Tom Scullion (t-scullion@tamu.edu)

Date: January 18th, 2011

Subject: Lab Test, Distress (Crack) Survey, and Construction Reports for
US 83, Loop 20, US 59, & Spur 400 (Webb County, Laredo District)



Summary

This Tech Memo provides a summary of the Lab Test, Distress Survey, and Construction Reports for the RAP Test Sections in Laredo District. Based on extensive lab testing by TTI, the District elected to use the TTI mix-design (5.0% PG 64-22 + Crushed Gravel + 20% RAP) on three highways, namely Loop 20, US 59, and Spur 400. The control (original) mix-design (4.8% PG 70-22 + Crushed Gravel + 20% RAP) was placed on US 83. All mixes were placed as a 2 inches thick overlay by Anderson Colombia Company late summer 2010. While satisfactorily meeting the PG 70-22 bid requirements and performing better in the OT crack test, the Contractor was understood to have saved at least US \$5.00 per ton of HMA with the modified design.

Plans are to periodically monitor the test sections at least twice per year during the cold (crack evaluation) and hot (rutting evaluation) weather seasons, respectively including : (1) visual crack surveys, (2) rut measurements, (3) surface profiles (ride quality), (4) GPR, (5) skid measurements (with TxDOT help), (6) FWD (with TxDOT help), and (7) coring (where applicable).

Special thanks go to Ramon J. Rodriguez (TxDOT) and Anderson Colombia Company for permitting and assisting TTI Researchers conduct the survey, run GPR tests, record the construction process, and collect materials including plant-mix and cores for lab testing.

APPENDIX I: HMA MIX-DESIGN DETAILS AND LAB TEST REPORT

TYPE C MIX, SPEC ITEM 341

Asphalt-binder: Valero PG 64-22 & PG 70-22
 Aggregate type: A.C Crushed Gravel + 20% RAP + 1% lime

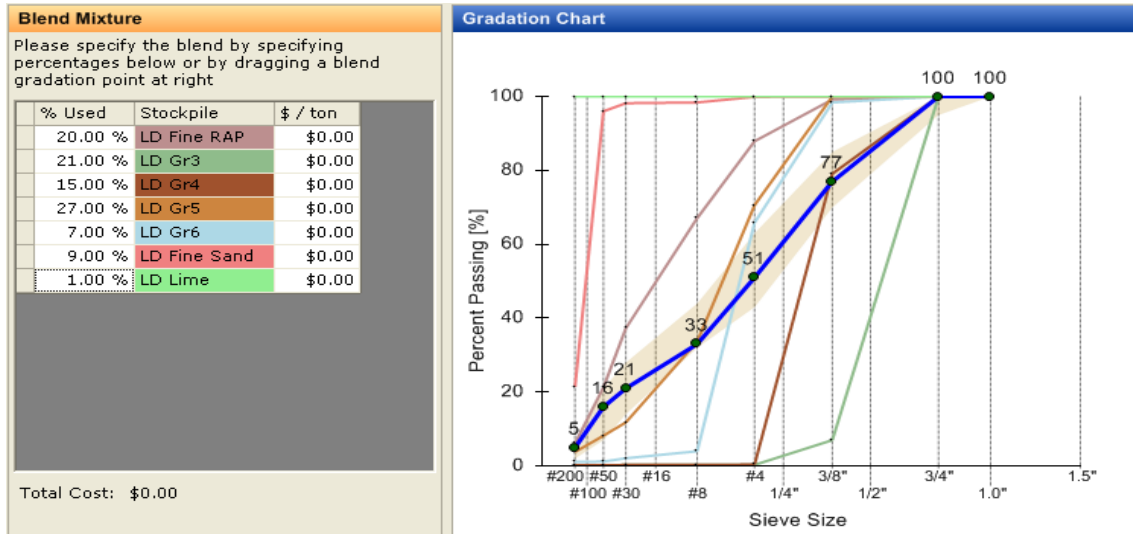


Figure I-1: Aggregate Gradation.

Table I-1: HMA Mix-Design Details.

Item	Control (Original) Mix-Design	TTI Modified Mix-Design
Mix type	Type C (Item 341)	Type C (Item 341)
Asphalt-binder	PG 70-22 (Valero)	PG 64-22 (Valero)
Aggregate	Crushed gravel (A.C)	Crushed gravel (A.C)
Aggregate blend	21% Gr3 + 15% Gr4 + 27% Gr5 + 7% Gr6 + 9% Fine Sand	21% Gr3 + 15% Gr4 + 27% Gr5 + 7% Gr6 + 9% Fine Sand
RAP	20% fine	20% fine
Anti-strip	1% lime	1% lime
Design OAC	4.8% PG 70-22	5.0% PG 64-22
Design lab TGC density	96.5%	96.5%
Rice	2.432	2.414
VMA ($\geq 13\%$)	14.4%	14.8%
Hamburg @ 20 000 load passes	2.9 mm	6.0 mm
Overlay test (OT)	38 cycles	200 cycles
IDT (85 – 200 psi)	140.5 psi	122.3 psi
SCB	156.0 psi	148.0 psi
Test section designation	Control	Modified
Highway where placed	US 83 ($\cong 6$ miles long)	1) Loop 20 ($\cong 1$ mile long) , 2) US 59 ($\cong 3$ miles long), & 3) Spur 400 ($\cong 1$ mile long)

Table I-2: Hamburg and OT Results for the Original Mix-Design (PG 70-22).

AC	Corresponding TGC Lab Density	VMA (≥ 13)	Hamburg (After 20 000 Passes)	Overlay (Cycles)
4.7%	96.0%	14.6	2.04 mm	24
4.8%	96.5%	14.4	2.9 mm	38
5.0%	97.0%	14.3	2.7 mm	46
5.2%	97.5%	14.4	2.9 mm	60
5.5%	98.0%	14.5	3.2 mm	73

Table I-3: Hamburg and OT Results for the TTI Modified Design (PG 64-22).

AC	Corresponding TGC Lab Density	VMA	Hamburg (After 20 000 Passes)	Overlay (Cycles)
4.8%	96.0%	14.7	5.4 mm	180
5.0%	96.5%	14.8	6.0 mm	200
5.2%	97.0%	14.8	6.5 mm	219
5.4%	97.5%	14.7	8.0 mm	311
5.6%	98.0%	14.7	9.7 mm	380

Table I-4: Detailed Hamburg Results for the TTI Modified Design (PG 64-22).

Hamburg Passes	4.8% AC	5.0% AC	5.2% AC	5.4% AC	5.6% AC
00 000	0.0 mm	0.0 mm	0.0 mm	0.0 mm	0.0 mm
05 000	3.3 mm	3.6 mm	4.0 mm	4.5 mm	5.2 mm
10 000	4.1 mm	4.3 mm	4.7 mm	5.5 mm	6.5 mm
15 000	4.9 mm	5.3 mm	5.6 mm	6.7 mm	8.1 mm
20 000	5.4 mm	6.0 mm	6.5 mm	8.0 mm	9.7 mm
Corresponding TGC density	96.0%	96.5%	97.0%	97.5%	98.0%

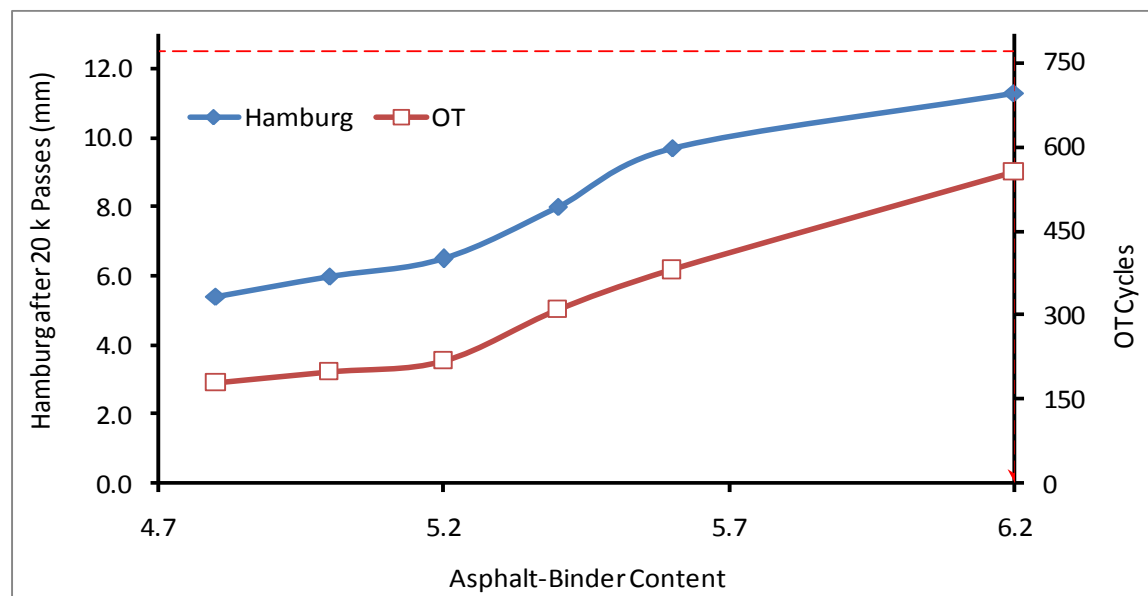


Figure I-2: Hamburg-OT Graphical Plots for the TTI Modified Design (PG 64-22).

NB: All Hamburg & OT samples were molded & tested at $7 \pm 1\%$ AV!

Table I-5: Mix-Design Sheet: Control (Original) Design.

MATERIAL CODE:		MIX TYPE:	ITEM341_C_Coarse_Surface		
MATERIAL NAME:	TYPE C PG70-22 RAP				
PRODUCER:	Anderson Colombia				
AREA ENGINEER:		PROJECT MANAGER:			

COURSE\LIFT:		STATION:		DIST. FROM CL:		CONTRACTOR DESIGN # :	
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	BIN FRACTIONS																		
	Bin No.1		Bin No.2		Bin No.3		Bin No.4		Bin No.5		Bin No.6		Bin No.7						
Aggregate Source:	IH-35		A.C.		A.C.		A.C.		A.C.		A.C.								
Aggregate Pit:	Fractionated		La Perla		La Perla		La Perla		La Perla		Fine Sand								
Aggregate Number:	Fine RAP		Gr 3		Gr 4		Gr 5		Gr 6				Lime						
Sample ID:															Combined Gradation				
Rap?:	Yes																		
Asphalt%:	4.6																		
Individual Bin (%):	20.0	Percent	21.0	Percent	15.0	Percent	27.0	Percent	7.0	Percent	9.0	Percent	1.0	Percent	100.0%	Lower & Upper Specification Limits	Resi		
Sieve Size:	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum. % Passing			Low er	Upper
1"	100.0	20.0	100.0	21.0	100.0	15.0	100.0	27.0	100.0	7.0	100.0	9.0	100.0	1.0	100.0	100.0	100.0	Yes	
3/4"	100.0	20.0	100.0	21.0	100.0	15.0	100.0	27.0	100.0	7.0	100.0	9.0	100.0	1.0	100.0	95.0	100.0	Yes	
3/8"	99.2	19.8	7.0	1.5	79.1	11.9	100.0	27.0	98.4	6.9	100.0	9.0	100.0	1.0	77.1	70.0	85.0	Yes	
No. 4	87.9	17.6	0.3	0.1	0.4	0.1	70.6	19.1	65.9	4.6	99.9	9.0	100.0	1.0	51.4	43.0	63.0	Yes	
No. 8	67.1	13.4	0.3	0.1	0.3	0.0	33.7	9.1	4.0	0.3	98.4	8.9	100.0	1.0	32.8	32.0	44.0	Yes	
No. 30	37.3	7.5	0.3	0.1	0.3	0.0	11.8	3.2	2.1	0.1	98.2	8.8	100.0	1.0	20.7	14.0	28.0	Yes	
No. 50	21.3	4.3	0.2	0.0	0.2	0.0	8.2	2.2	1.2	0.1	96.0	8.6	100.0	1.0	16.3	7.0	21.0	Yes	
No. 200	6.1	1.2	0.2	0.0	0.2	0.0	3.8	1.0	1.1	0.1	21.4	1.9	100.0	1.0	5.3	2.0	7.0	Yes	

Not w ithin specifications # Not cumulative

Lift Thickness, in:	
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Asphalt Source & Grade:	Valero PG 70-22	Binder Percent, (%):	4.8	Asphalt Spec. Grav.:	1.033
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Antistripping Agent:	Lime	Percent, (%):	1%		
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Remarks:
 Design prepared by : Maghsoud Tahmoressi, PE TxDOT Level II Certificate # 169

Table I-6: Mix-Design Sheet: Control (Original) Design.

Target Density, %:	96.5
Number of Gyration:	TxDOT

CRM* Content	
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TEST SPECIMENS							Mixture
Asphalt Content (%)	Specific Gravity Of Specimen (Ga)	Maximum Specific Gravity (Gr)	Effective Gravity (Ge)	Theo. Max. Specific Gravity (Gt)	Density from Gt (Percent)	VMA (Percent)	Indirect Tensile Strength (psi)
4.0	2.310			2.461	93.9	15.1	120
4.5	2.333	2.455	2.625	2.443	95.5	14.7	
5.0	2.355	2.432	2.619	2.426	97.1	14.3	
5.5	2.361	2.391	2.589	2.409	98.0	14.5	
6.0	2.366			2.392	98.9	14.8	

Effective Specific Gravity:	2.611
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Estimated Percent of Stripping, %:	0
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Optimum Asphalt Content :	4.8
VMA @ Optimum AC:	14.4

Interpolated Values	
Specific Gravity (Ga):	2.347
Max. Specific Gravity (Gr):	2.440
Theo. Max. Specific Gravity (Gt):	2.432

Table I-7: Mix-Design Sheet: TTI Modified Design.

MATERIAL CODE:		MIX TYPE:	ITEM341_C_Coarse_Surface		
MATERIAL NAME:	TYPE C PG 64-22 RAP				
PRODUCER:	Anderson Colombia				
AREA ENGINEER:		PROJECT MANAGER:			

COURSE/LIFT:		STATION:		DIST. FROM CL:		CONTRACTOR DESIGN #:	
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BIN FRACTIONS																								
	Bin No.1		Bin No.2		Bin No.3		Bin No.4		Bin No.5		Bin No.6		Bin No.7											
Aggregate Source:	IH-35		A.C.		A.C.		A.C.		A.C.		A.C.													
Aggregate Pit:	Fractionated		La Perla		La Perla		La Perla		La Perla		Fine Sand													
Aggregate Number:	Fine RAP		Gr 3		Gr 4		Gr 5		Gr 6				Lime											
Sample ID:																								
Rap?:	Yes																							
Asphalt%:	4.6																							
																	Total Bin							
Individual Bin (%):	20.0	Percent	21.0	Percent	15.0	Percent	27.0	Percent	7.0	Percent	9.0	Percent	1.0	Percent	100.0%	Lower & Upper Specification Limits			Restricted Zone			Individual % Retained	Cumulative % Retained	Sieve Size
Sieve Size:	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum.% Passing	Wtd Cum. %	Cum. % Passing	Lower	Upper	Within Spec's	Lower	Upper	Within Spec's			
1"	100.0	20.0	100.0	21.0	100.0	15.0	100.0	27.0	100.0	7.0	100.0	9.0	100.0	1.0	100.0	100.0	100.0	Yes				0.0	0.0	1"
3/4"	100.0	20.0	100.0	21.0	100.0	15.0	100.0	27.0	100.0	7.0	100.0	9.0	100.0	1.0	100.0	95.0	100.0	Yes				0.0	0.0	3/4"
3/8"	99.2	19.8	7.0	1.5	79.1	11.9	100.0	27.0	98.4	6.9	100.0	9.0	100.0	1.0	77.1	70.0	85.0	Yes				22.9	22.9	3/8"
No. 4	87.9	17.6	0.3	0.1	0.4	0.1	70.6	19.1	65.9	4.6	99.9	9.0	100.0	1.0	51.4	43.0	63.0	Yes				25.7	48.6	No. 4
No. 8	67.1	13.4	0.3	0.1	0.3	0.0	33.7	9.1	4.0	0.3	98.4	8.9	100.0	1.0	32.8	32.0	44.0	Yes				18.6	67.2	No. 8
No. 30	37.3	7.5	0.3	0.1	0.3	0.0	11.8	3.2	2.1	0.1	98.2	8.8	100.0	1.0	20.7	14.0	28.0	Yes				12.0	79.3	No. 30
No. 50	21.3	4.3	0.2	0.0	0.2	0.0	8.2	2.2	1.2	0.1	96.0	8.6	100.0	1.0	16.3	7.0	21.0	Yes				4.5	83.7	No. 50
No. 200	6.1	1.2	0.2	0.0	0.2	0.0	3.8	1.0	1.1	0.1	21.4	1.9	100.0	1.0	5.3	2.0	7.0	Yes				10.9	94.7	No. 200

Not within specifications # Not cumulative

Lift Thickness, in:	
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Asphalt Source & Grade:	Valero PG 64-22	Binder Percent, (%):	5.0	Asphalt Spec. Grav.:	1.033
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Antistripping Agent:	Lime	Percent, (%):	1%
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Table I-9: Mix-Design Sheet: TTI Modified Design.

Target Density, %:	96.5			
Number of Gyration:	TxDOT		CRM* Content	

TEST SPECIMENS							Mixture Evaluation @ Optimum Asphalt Content			
Asphalt Content (%)	Specific Gravity Of Specimen (Ga)	Maximum Specific Gravity (Gr)	Effective Gravity (Ge)	Theo. Max. Specific Gravity (Gt)	Density from Gt (Percent)	VMA (Percent)	Indirect Tensile Strength (psi)	Hamburg Wheel Tracking Test		Overlay Number
								Number of cycles	Rut depth (mm)	
4.2	2.311	2.425	2.577	2.441	94.7	14.7		20 000	6.0	
4.7	2.323	2.428	2.601	2.424	95.8	14.7				
5.2	2.334	2.409	2.599	2.407	97.0	14.8				
5.7	2.350	2.395	2.602	2.390	98.3	14.6				
6.2	2.359	2.377	2.601	2.373	99.4	14.8				

Effective Specific Gravity:	2.596
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Optimum Asphalt Content :	5.0
VMA @ Optimum AC:	14.8

Interpolated Values	
Specific Gravity (Ga):	2.329
Max. Specific Gravity (Gr):	2.417
Theo. Max. Specific Gravity (Gt):	2.414

Estimated Percent of Stripping, %:	0
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APPENDIX II: DISTRESS SURVEY REPORT AND GPR TESTING

Table II-1. Hwy and Test Section Locations.

#	Hwy	TRM		GPS		Physical	Elev. (ft)
		Start	End	Start	End	Start - End	Start - End
1	US 59	826 + 1.843	828 + 1.495	N 27° 31.712'; W 099° 26.807'	N 27° 31.865'; W 099° 30.127'	Bridge junction with Loop 20 (Bob Bullock) - At junction with IH 35	423 - 403
2	Spur 400	432 + 0.014	432 + 1.140	-	-	-	-
3	Loop 20	430 + 0.894	430 + 1.569	N 27° 31.138'; W 099° 26.922'	N 27° 30.635'; W 099° 26.905'	Traffic lights with road leading to Walmart (Bob Bullock loop between 2300 & 400) - Bridge	425 - 439
4	US 83	720 + 1.359	726 + 2.004	N 27° 26.856'; W 099° 28.673'	N 27° 28.295'; W 099° 28.620'	Traffic lights at crossing of Sierra Vista & Santa Martha roads (Valero gas station) - Traffic lights at junction with Palo Blanco.	439 - 401

Table II-2. Crack Mapping on Existing PVMNT Prior to HMA Overlay.

Hwy/Section	Lane	Location	Elevation	Severity?	Comment
US 59	Outside EB	N 27° 31.826' ; W 099° 28.342	502ft	High	Five severe transverse cracks were counted around this location averaging 18" long
US 59	Outside WB	TRM 827+0.000	-	Medium	Eight transverse cracks counted around this location averaging 15" long
US 59	Outside & Inside EB	TRM 826+2.600	-	High	Transverse and longitudinal cracks around this TRM
US 59	Outside EB (Wheel path)	TRM 826+2.000	-	Medium	Fatigue cracking in wheel path
US 83	Outside SB	N 27° 27.579' ; W 099° 28.660	452 ft	High	Three severe transverse cracks were counted around this location averaging 18.6" long
Spur 400	Outside EB	TRM 432 + 0.500	-	Medium	One transverse crack about 10" long
Loop 20	Outside SB	TRM 430 + 1.000	-	Low	One transverse crack about 7.5" long



Figure II-1. Example of Cracking on US 83.



Figure II-2. Example of Cracking on US 59 Prior to 2" HMA Overlay.



Figure II-3. Example of Cracking on US 59 Prior to 2" HMA Overlay.

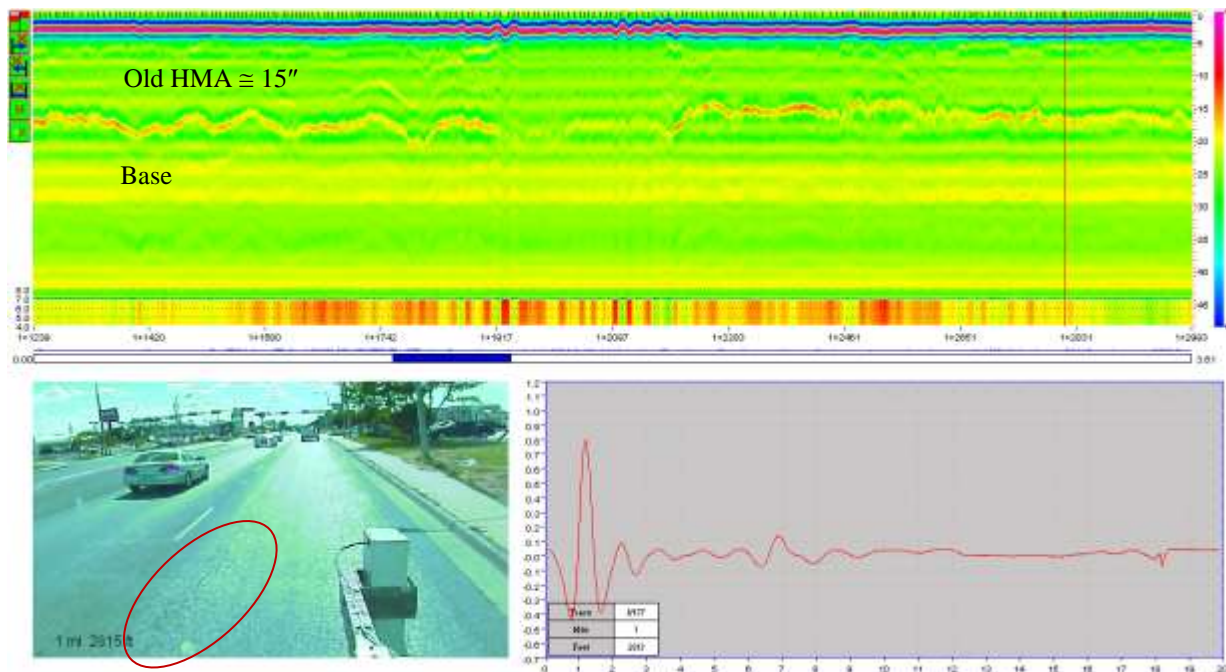


Figure II-1. GPR Test Runs on US 59 Prior to 2" HMA Overlay Placement - WB Direction.

(Existing HMA Layer Thickness \rightarrow Variable). Existing HMA on this Highway Had Transverse, Longitudinal, and Fatigue Cracking.

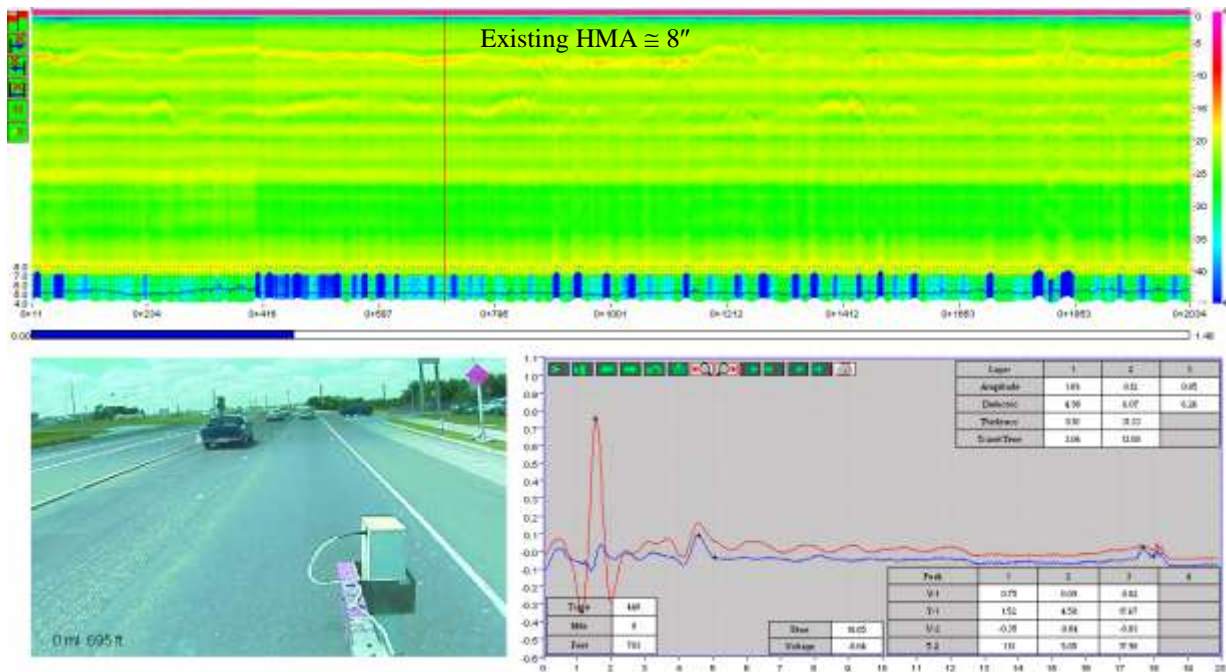


Figure II-2. GPR Test Runs on Loop 20 Prior to 2" HMA Overlay Placement - SB Direction.

(Existing HMA Layer Thickness \rightarrow More Consistent than US 59); Very Little Distress on this Highway.

APPENDIX III: CONSTRUCTION REPORT

Highways: US 83, Loop 20, US 59, and Spur 400; Laredo, Webb County, TX.
 Construction Date: Summer 2010 (June through August) @ Night
 Contractor: Anderson Colombia Co.
 Construction: HMA overlay with intermittent Mill & Inlay on some sections
 HMA mix: Type C (Item 341) – Coarse Surface
 Bid price: US \$58.00 per ton

Table III-1. Highway Section Details.

#	Hwy	Location		Length (miles)	HMA Overlay	HMA Mix (Item 341)
		Start	End			
1	US 59	TRM 826 + 1.843 N 27° 31.712'; W 099° 26.807'	TRM 828 + 1.495 N 27° 31.865'; W 099° 30.127'	≅ 3	2 inches	<u>Modified:</u> Type C = 5.0% PG 64-22 + Crushed Gravel + 20% Fine RAP + 1% Lime
2	Spur 400	TRM 432 + 0.014	TRM 432 + 1.140	≅ 1	2 inches	
3	Loop 20	TRM 430 + 0.894 N 27° 31.138'; W 099° 26.922'	TRM 430 + 1.569 N 27° 30.635'; W 099° 26.905'	≅ 1	2 inches	
4	US 83	TRM 720 + 1.359 N 27° 26.856'; W 099° 28.673'	TRM 726 + 2.004 N 27° 28.295'; W 099° 28.620'	≅ 6	2 inches	<u>Control:</u> Type C = 4.8% PG 70-22 + Crushed Gravel + 20% Fine RAP + 1% Lime

Table III-1. QC/QA Test Results on Plant-Mix, Cores, & In-situ HMA Mat.

#	Item	US 59 (Modified Mix)	Spur 400 (Modified Mix)	Loop 20 (Modified Mix)	US 83 (Control Mix)
1	Design AC= Avg. Ignition Oven AC (TxDOT) = Avg. Ignition Oven AC (TTI) = (Tolerance = ±0.3%)	5.0% 5.2% 5.1%	5.0% 5.1% 5.1%	5.0% 5.2% 5.3%	4.8% 4.9% 5.0%
2	Lab design density= Avg. QC core density (TxDOT) = Avg. core density (TTI) =	96.5% 96.4% 96.3%	96.5% 96.8% 96.5%	96.5% 96.5% 96.4%	96.5% 96.4% 96.2%
3	Avg. QA IRI (30-90)= Avg. QA PSI=	88 3.9	- -	- -	- -
4	TTI Hamburg on plant-mix = TTI OT on plant-mix = TTI OT on core =	4.4 mm 136 -	- - -	4.8 mm 186 297	5.6 mm - 158
5	Compaction rolling pattern	Breakdown: 3 passes vib (steel wheel roller); Finisher: 2 to 4 passes static (steel wheel roller)			

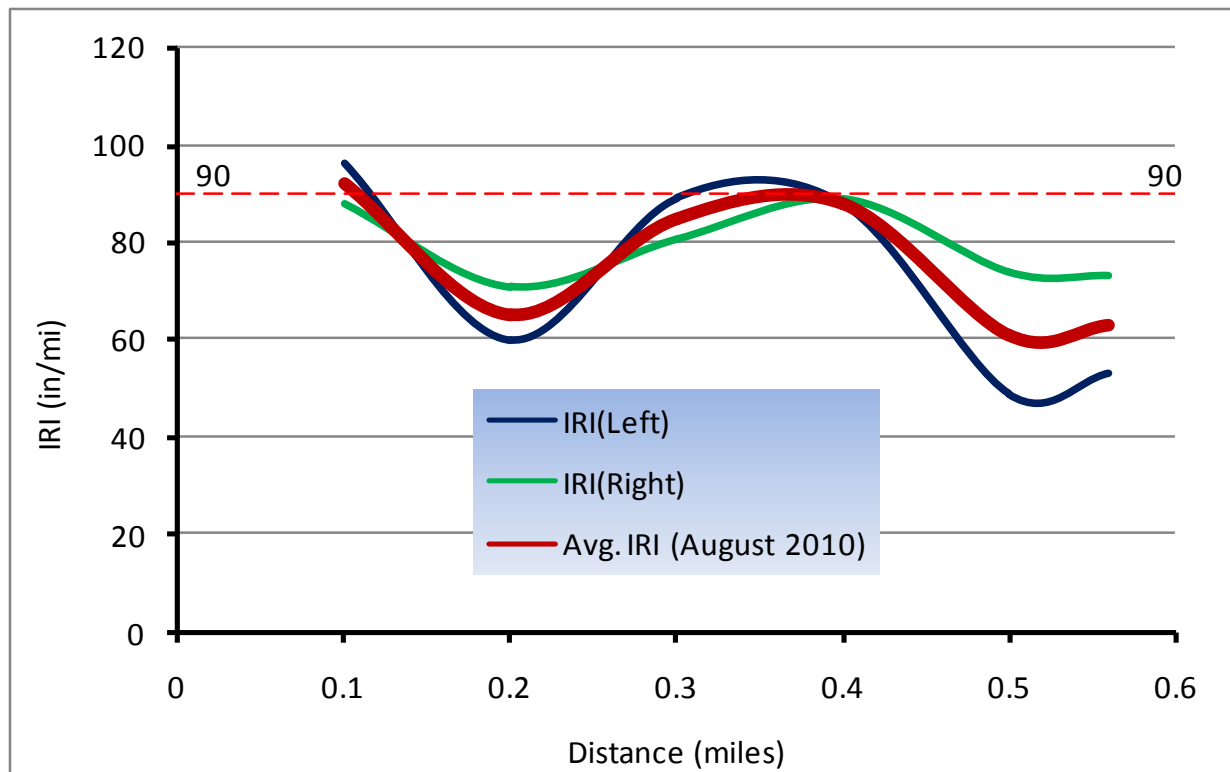


Figure III-1. Example IRI (QA) Plot for Loop 20 (August 2010).

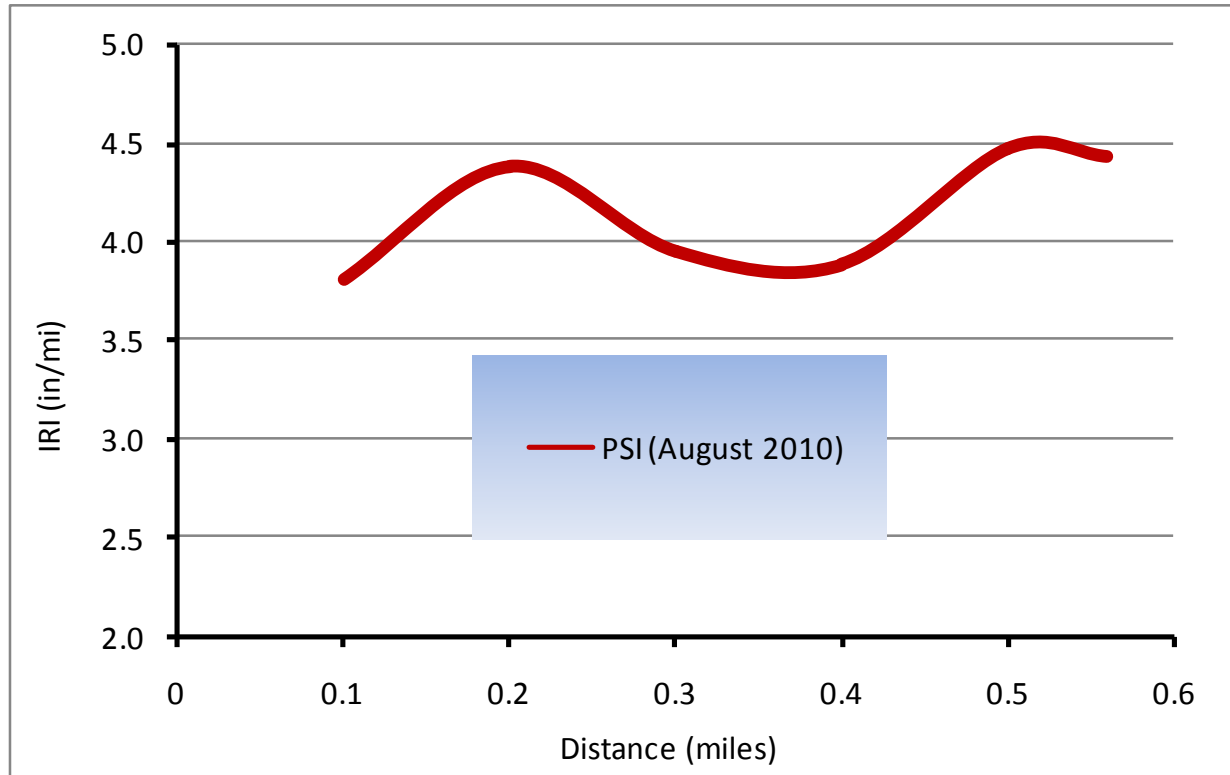


Figure III-2. Example PSI (QA) Plot for Loop 20 (August 2010).

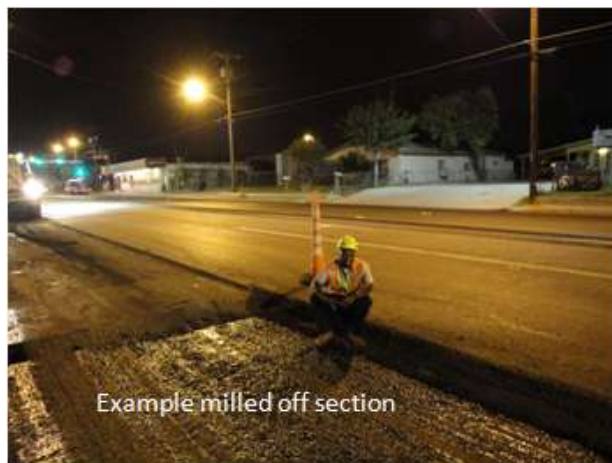


Figure III-3. Example of a Milled Section on US 59 and Paver.



Figure III-3. Example Completed 2" Thick HMA Mats on Loop 20 and US 59.
(5.0%PG 64-22 + Crushed Gravel + 20% RAP + 1% Lime)



Figure III-5. Example Completed 2" Thick HMA Mat on US83.
(4.8%PG 70-22 + Crushed Gravel + 20% RAP + 1% Lime)