

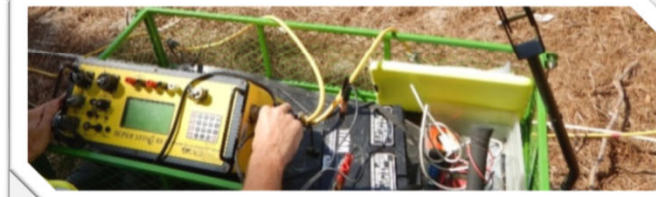
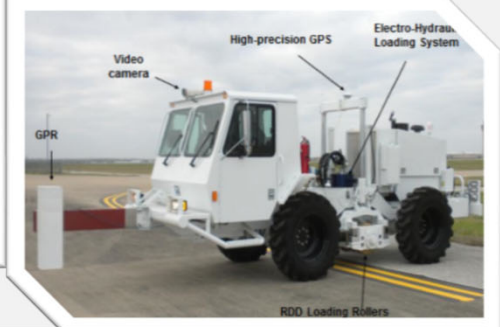
TxDOT's Pavement Innovative Tools and Techniques



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September 29, 2021

Outline

- Discuss pavement testing equipment.
 - GPR
 - **LiDAR**
 - FWD
 - **TPAD**
 - Profiler
 - **ERT**
 - **Web Soil Survey**
 - DCP
 - **P-WIM**

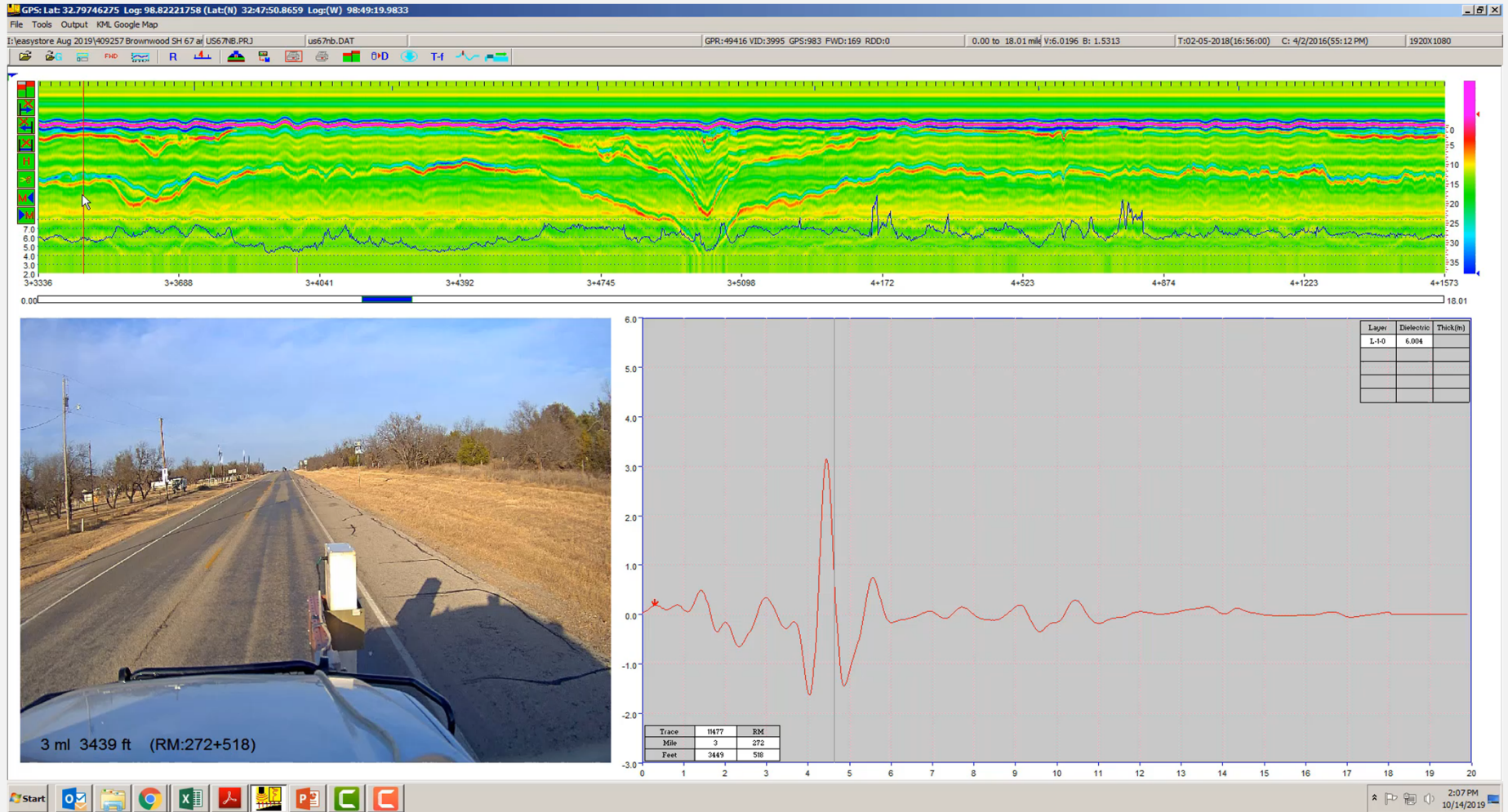


Air-Coupled GPR, 1GHz Antenna System

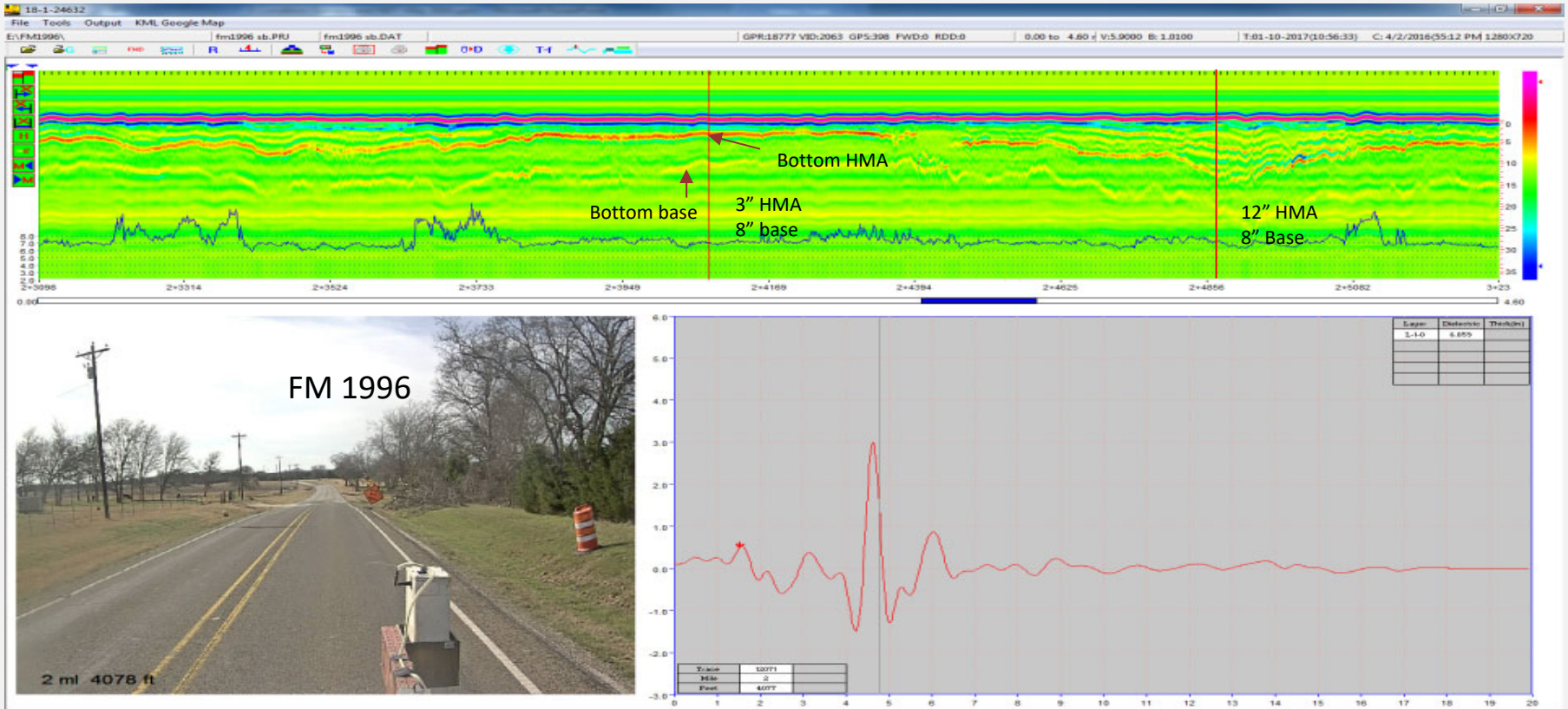


- Integrated HD video, GPS.
- Highway speed data collection.
- 20-inch penetration depth.
- Data analysis with PaveCheck.
- TxDOT owns 5 antennas

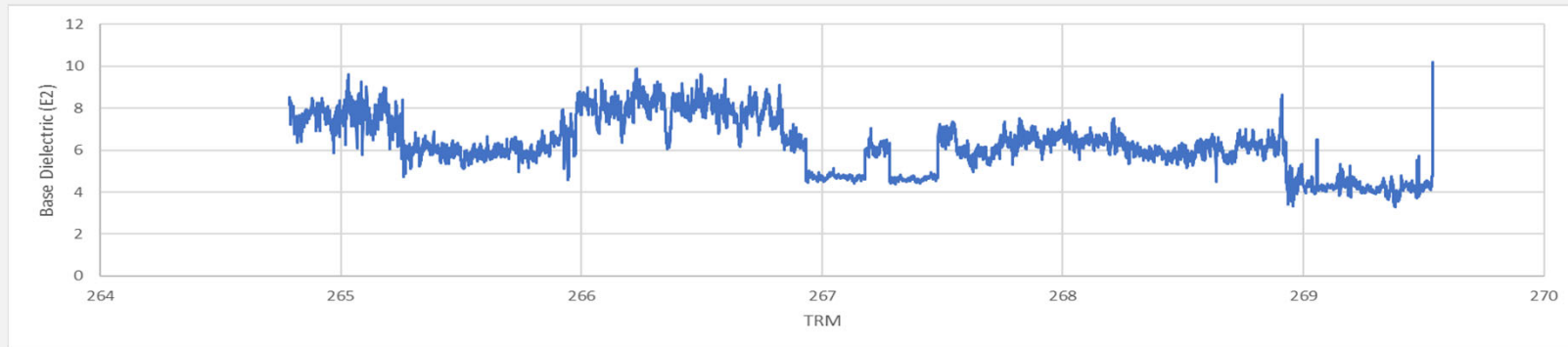
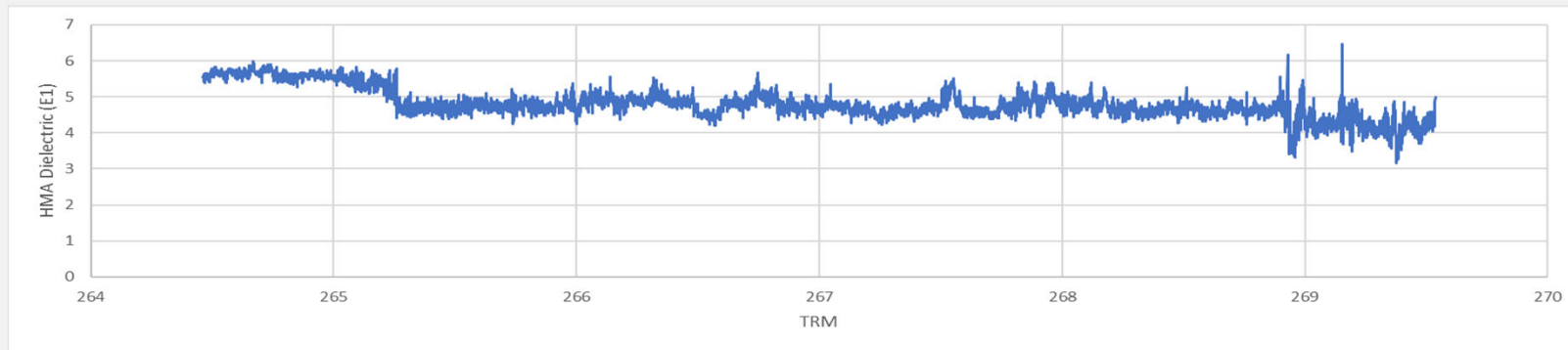
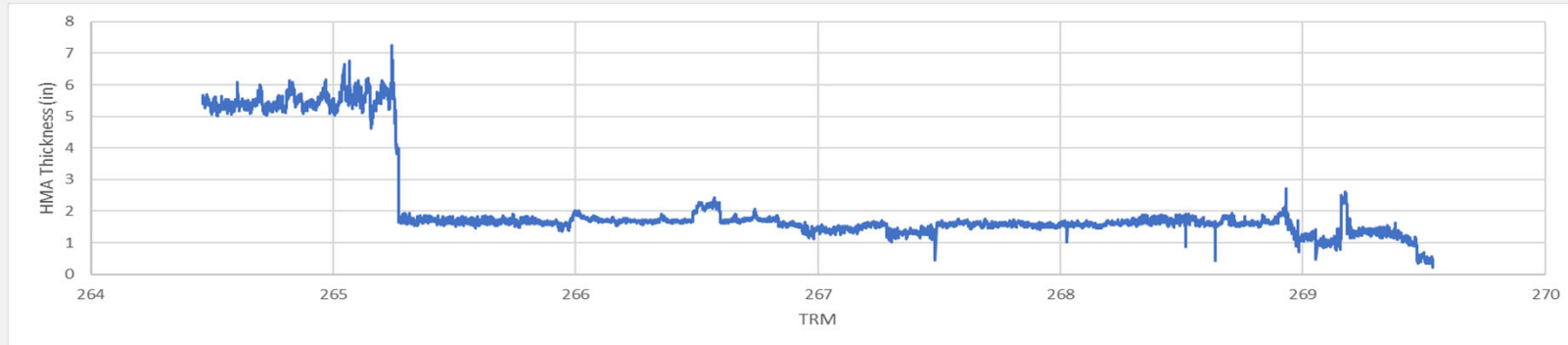
Demo of TxDOT's GPR display system



Problematic GPR project work suspended – change order



Typical TxDOT summary GPR for a project



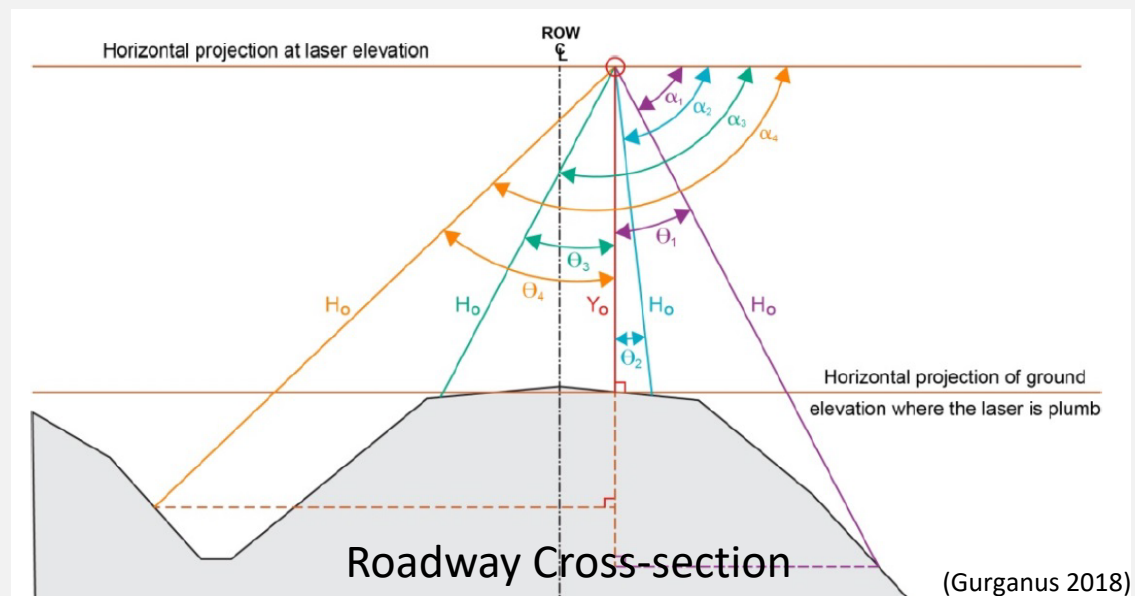
Mobile LiDAR Scanner



- Laser-based imaging system (Mobile Total Station)
- Provides a right-of-way geometric evaluation to predict surface drainage behavior.
- Freeway speed data collection.

Mobile LiDAR System

- Method
 - Scanning array of laser pulses.
 - Returning pulse provides reflectivity of surface and distance in relation to the angle.
 - Correction with inertial and accelerometer data.



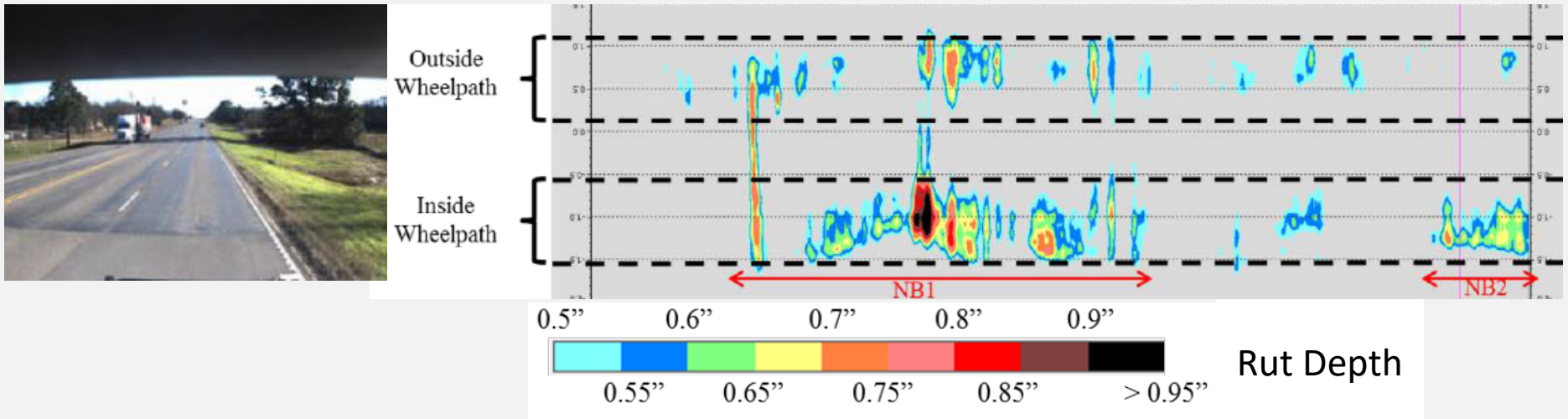
Mobile LiDAR System

- Equipment
 - SICK Laser Scanner
 - Cameras,
 - GPS,
 - Inertial measurement unit,
 - 3D accelerometer.
- Constructed by Roadscanners (Finland)



Mobile LiDAR System

- Measures
 - Rutting
 - Ditch depths and grade
 - Cross-slope
 - Drainage basins
- Data analysis programs under development



(Gurganus 2018)

Mobile LiDAR System

- Benefits for Accelerated Construction
 - Forensic evaluation for drainage problems.
 - Information for new construction.
 - More suited for asset management.
- Limitations and Availability
 - Complexity of data analysis.
 - TxDOT owns 1 system.

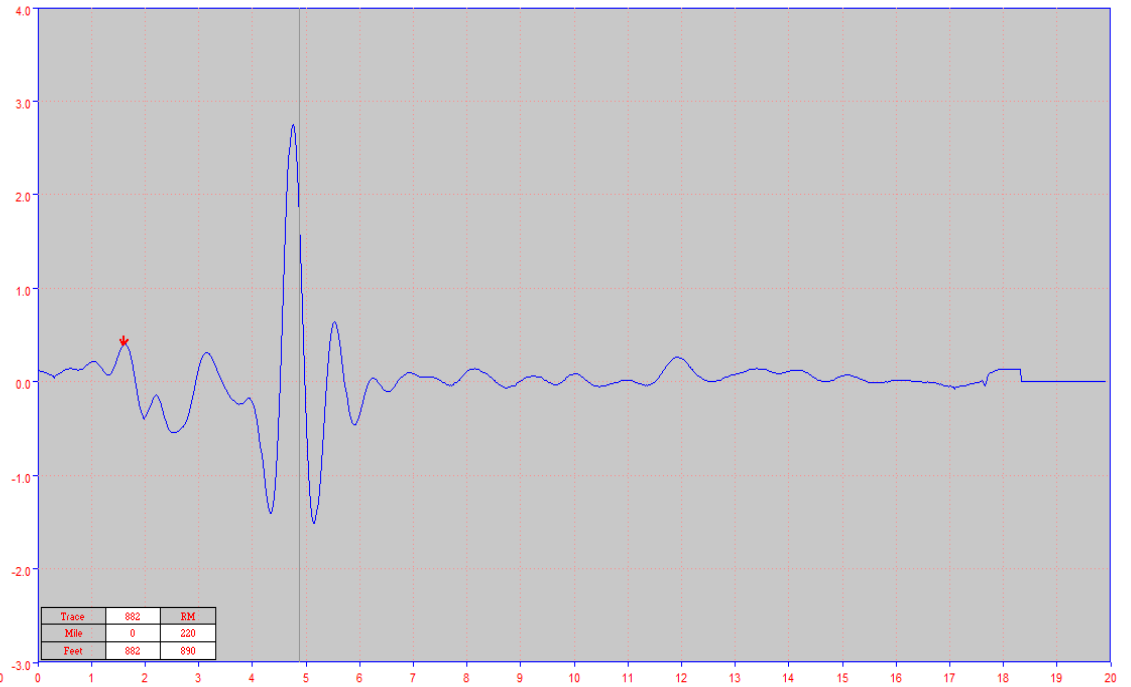
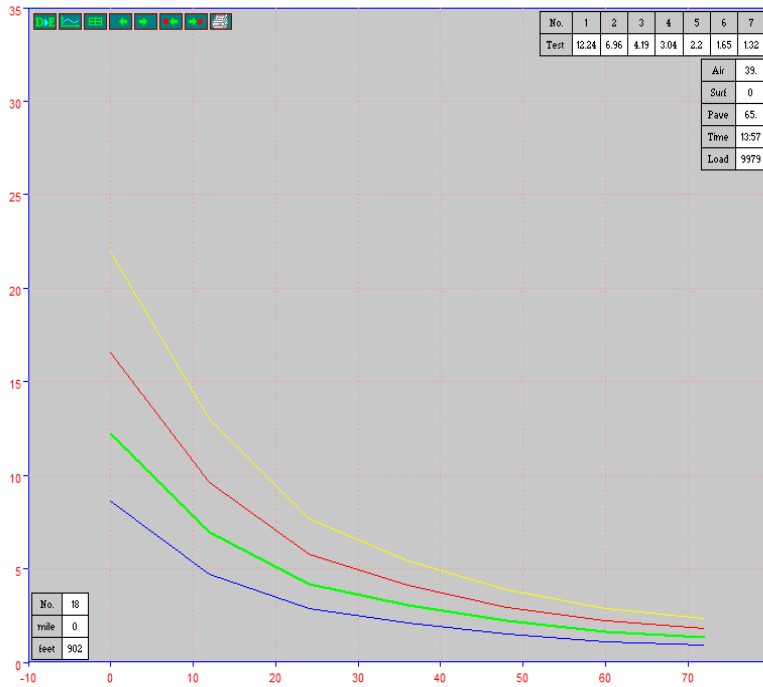
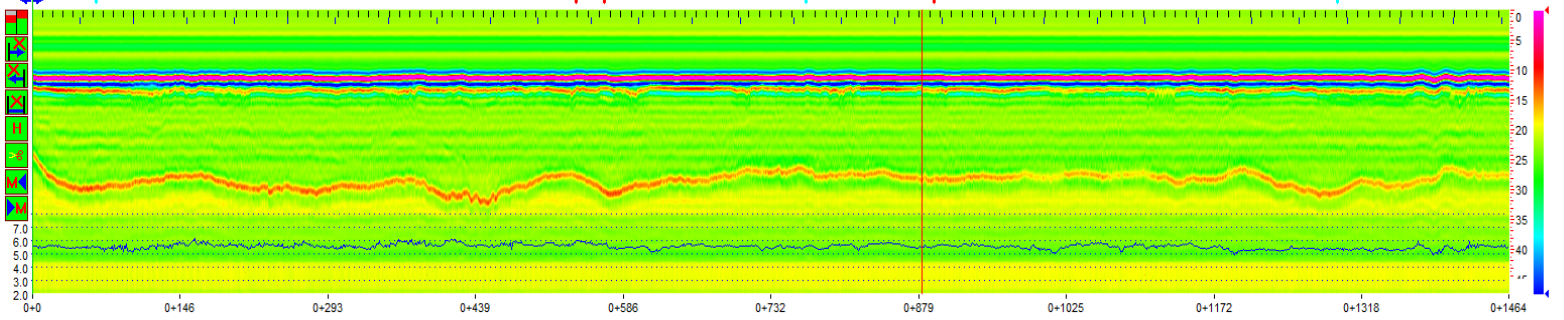
Falling Weight Deflectometer



- Load-deflection response testing system.
- Used to characterize pavement layer stiffness.
- Static data collection (traffic control required).

Merging GPR and FWD data

18-1-24632-0-1
 File Tools Output KML Google Map Kept Result
 409901 GPR School Sept 2021\GPR data\Annex ANNE_X_GPR.PRJ Annex_GPR.DAT Test in Anex
 GPR:1801 VID:172 GPS:0 FWD:37 0.00 to 0.34 mil V:5.8010 B: 1.0332 T:01-23-2003(14:24:33) C: () 1280X720



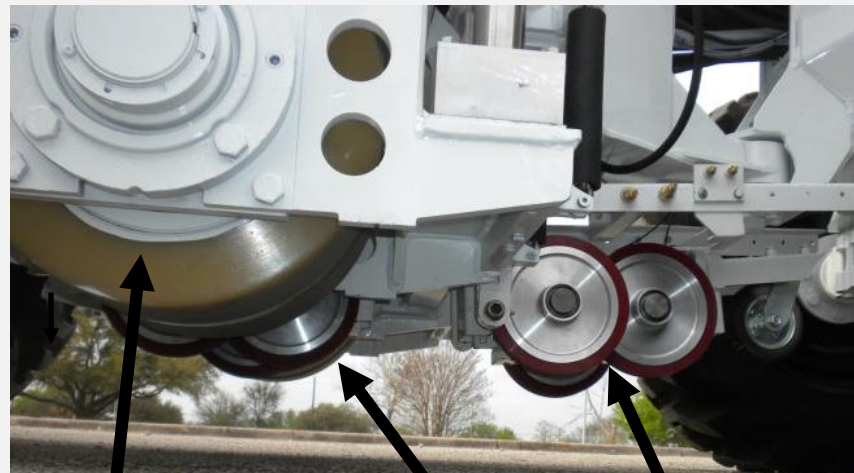
Total Pavement Acceptance Device (TPAD)



- Rolling dynamic deflectometer for continuous deflection profiling.
- Slow driving speed. (Traffic control needed).

Total Pavement Acceptance Device

- Method
 - Heavy vibrating wheel creates continuous deflection basin, measured by 2 rolling sensors.
 - Layer stiffness back-calculated similar to FWD.
 - Integrated GPR, GPS, and HD video.



**Loading
Roller**

**Rolling
Sensor #1**

**Rolling
Sensor#2**





Core drops in hole

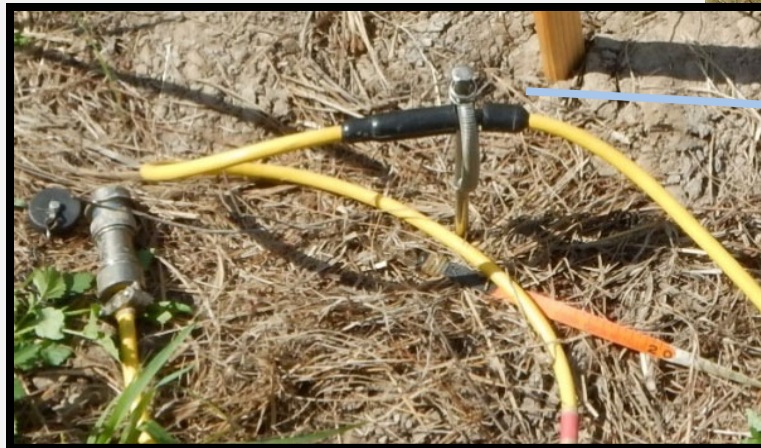
Location	Lane	Void under slab	Void under CTB
1) Near Spec's	Center	1.5 inch	2 inch
2) After End of patching	Center	2.5 inch	7 inch
3) 500 ft from Boheme	Outside	2 inch	2 inch

TPAD

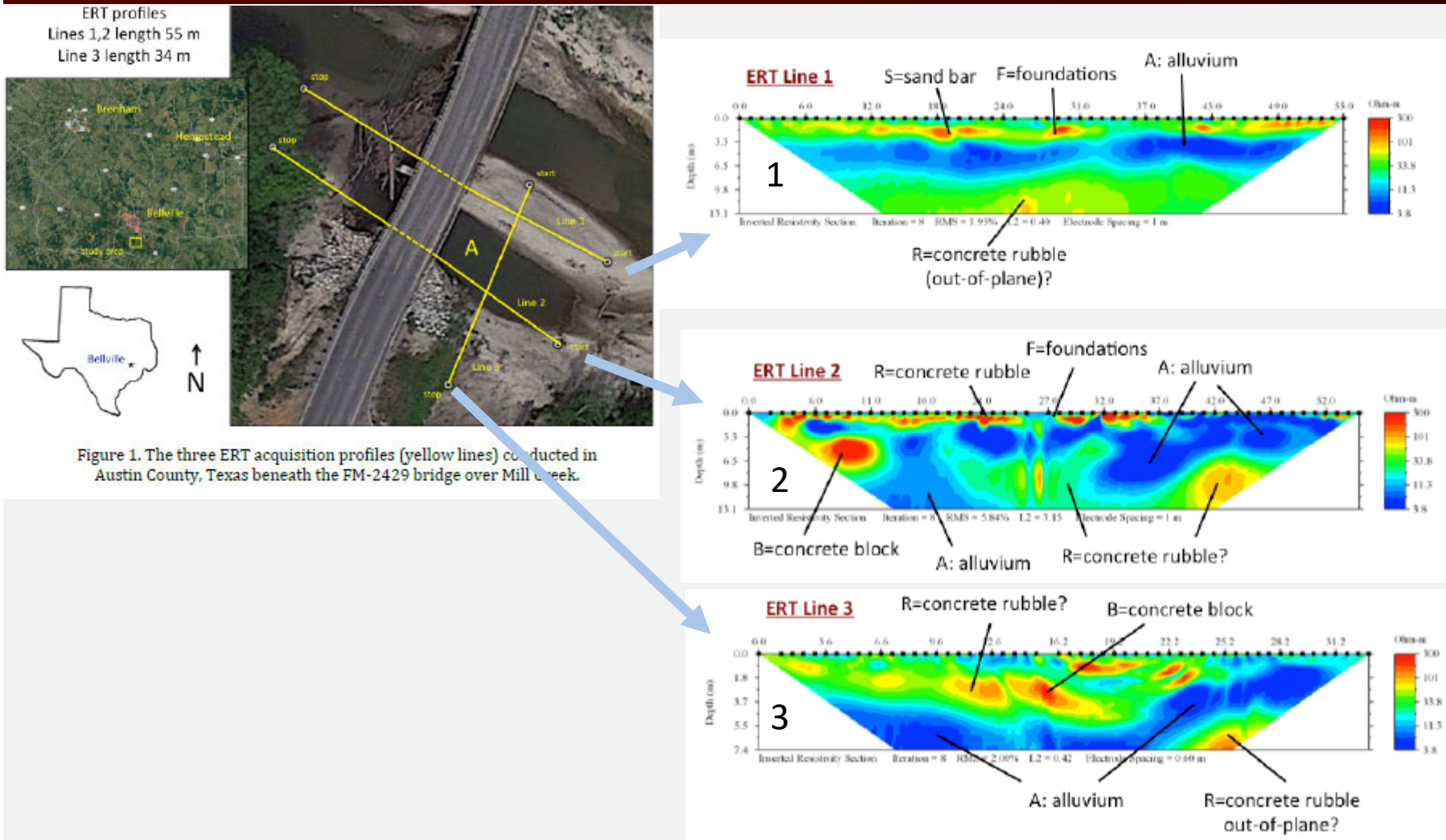
- Benefits for Accelerated Construction
 - Efficient forensic investigations.
 - Assess alternative M&R strategies.
 - Timely decision making.
 - Test of load transfer in jointed concrete.
- Limitations and Availability
 - Not suitable for layers <3 inches thick.
 - Traffic control required.
 - TxDOT owns 1 TPAD.

Electrical Resistivity Tomography (ERT)

- geophysical survey that can indicate subsurface geological conditions.



ERT – Example Project



ERT

- Benefits for Accelerated Construction
 - Identify locations with high moisture content
 - Identify locations with unusual subsurface conditions
 - Timely decision making.
- Limitations and Availability
 - Experienced personnel are needed to collect and analyze the data.
 - Contact TTI for testing
 - *Mark Everett, Dept. of Geology and Geophysics, Texas A&M University*

USDA Web Soil Survey

- Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey.
 - <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>
- Limitations and Availability
 - Free access web site supported by the United States Department of Agriculture
 - Limitations in the data is described when using the web site.



Portable Weigh In Motion (p-WIM)

General

- The p-WIM is a traffic data collection system that is used to measure traffic characteristics.
- Traffic control is required for the setup and removal of the system however, it is not required during data collection.

Measured Properties

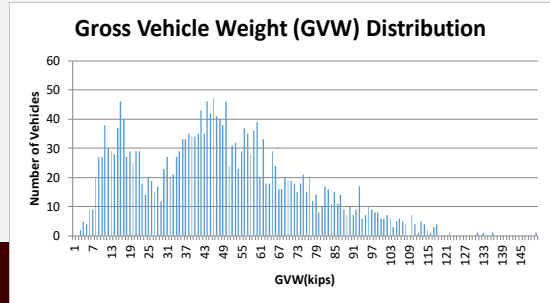
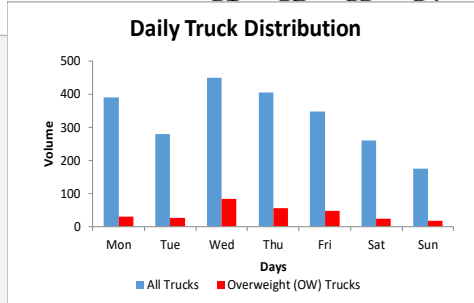
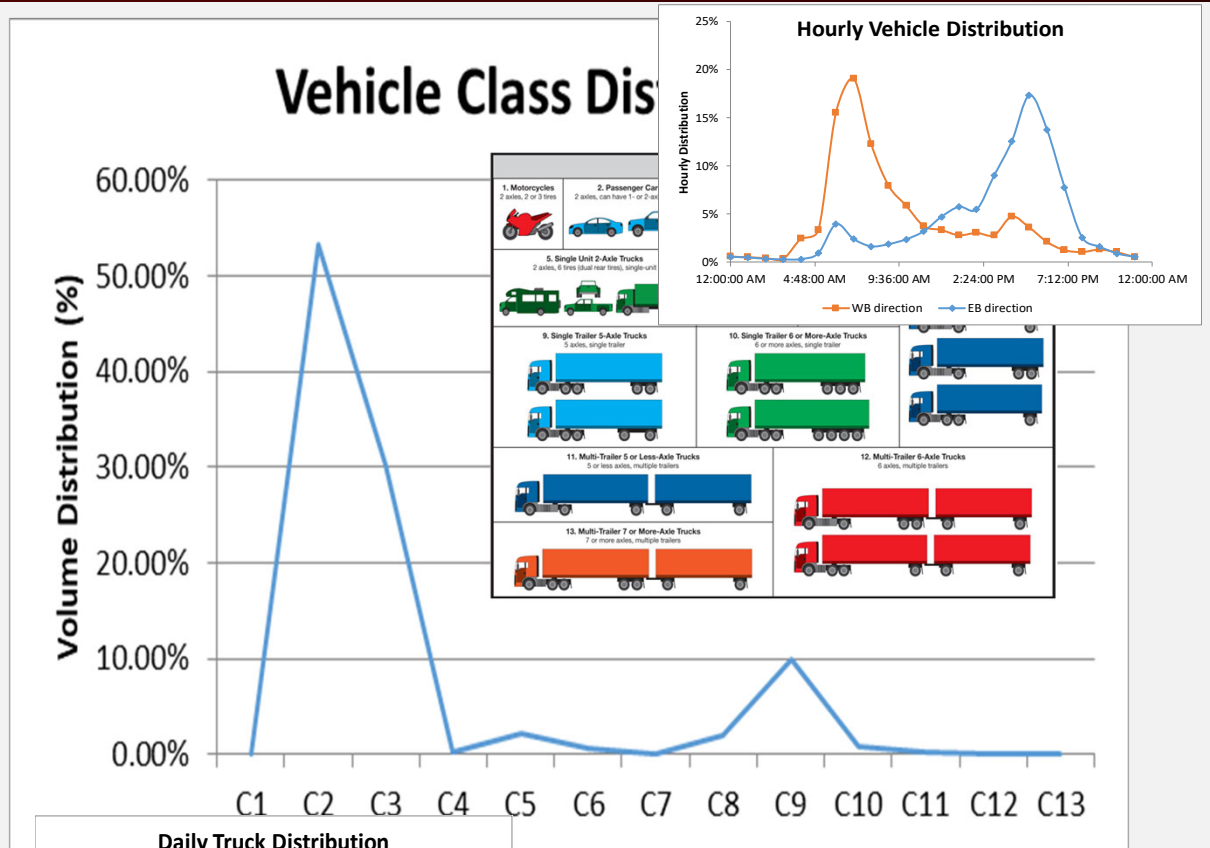
- Site-specific field traffic measurements including
 - Traffic Volume
 - Vehicle Classification
 - Axle loads
 - Vehicle weights.

Limitations and Availability

- This is an emerging technology from recent research. TTI has five (5) systems.

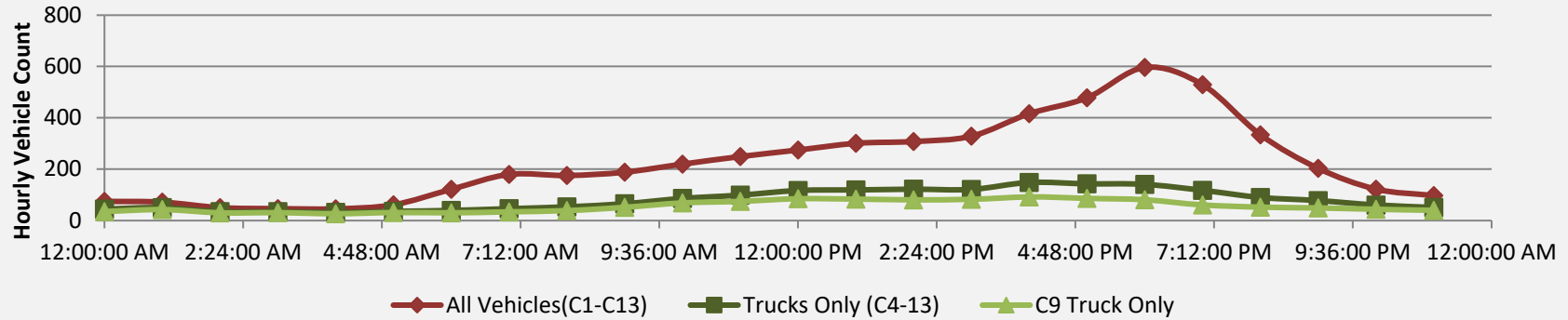


p-WIM



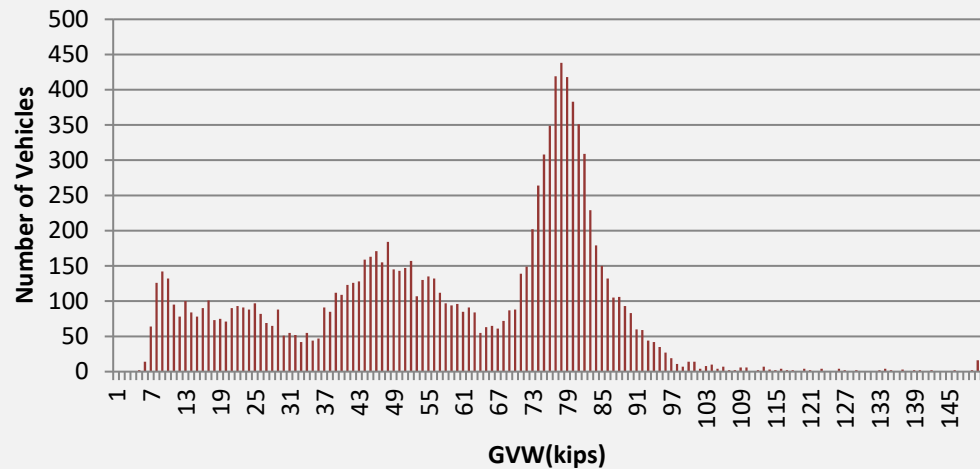
p-WIM – Example Data

Hourly Count



18-kip ESAL	Total	Daily
Steering Axles	2316	386
Single Axles (non-steering)	1492	249
Total Single Axles	3808	635
Tandem Axles	10403	1734
Tridem Axles	373	62
Quad Axles	78	13
Total 18-kip ESAL	14662	2444
Truck Factor(TF)	1.27	1.27

GVW Distribution



p-WIM

FLEXIBLE- Average TF per Hwy per District							RIGID - Average TF per Hwy per District						
District	FM Rds	IH Rds	RM Rds	SH Rds	US Rds	District Avg	District	FM Rds	IH Rds	RM Rds	SH Rds	US Rds	District Avg
Abilene		1.15			1.41	1.28	Abilene		1.32			1.63	1.48
Amarillo	1.54	1.09				1.32	Amarillo	1.78	1.25				1.52
Atlanta	0.98	1.22			0.97	1.06	Atlanta	1.13	1.44			1.12	1.23
Austin		1.29		1.15	1.12	1.19	Austin		1.86		1.33	1.54	1.58
Bryan				1.22		1.22	Bryan				1.41		1.41
Corpus Christi					1.44	1.44	Corpus Christi					1.66	1.66
El Paso		1.08	1.07			1.08	El Paso		1.24	1.23			1.24
Fort Worth		1.13		1.11		1.12	Fort Worth		1.30		1.28		1.29
Lubbock		0.98			1.13	1.06	Lubbock		1.13			1.30	1.21
Odessa	1.65	1.30	1.63	1.59	1.51	1.54	Odessa	1.91	1.60	1.74	1.86	1.88	1.80
Paris				0.88		0.88	Paris				1.02		1.02
Pharr					0.91	0.91	Pharr					1.05	1.05
San Angelo				1.25		1.25	San Angelo				1.60		1.60
San Antonio		1.14				1.14	San Antonio		1.31				1.31
Waco				1.22	1.23	1.23	Waco				1.39	1.39	1.39
Wichita Falls					0.96	0.96	Wichita Falls					1.12	1.12
Overall Avg TF per Hwy =	1.39	1.15	1.35	1.20	1.19	1.18	Overall Avg TF per Hwy =	1.61	1.38	1.48	1.41	1.41	1.39

Average (Avg) & TF Ranges per Hwy per District | Ongoing Work In Progress !!!

p-WIM

ADT & ADTT Lane Distribution (%) for a 4Lane-Hwy with 2-Lanes in One Direction | **Ongoing Work In Progress !!!**

%age ADT (All Vehicles) Distribution per Lane				%age ADTT (Trucks Only) Distribution per Lane			
District	Hwy	Outside Lane (OL)	Inside Lane (IL)	District	Hwy	Outside Lane (OL)	Inside Lane (IL)
Amarilla	IH 40	62%	38%	Amarilla	IH 40	86%	14%
Austin	SH 130	55%	45%	Austin	SH 130	84%	16%
Corpus Christi	IH 69	59%	41%	Corpus Christi	IH 69	72%	28%
El Paso	IH 10	56%	44%	El Paso	IH 10	73%	27%
Odessa	FM 1788	63%	37%	Odessa	FM 1788	68%	32%
Odessa	IH 20	57%	43%	Odessa	IH 20	70%	30%
Odessa	SH 302	67%	33%	Odessa	SH 302	84%	16%
Odessa	SH 349	79%	21%	Odessa	SH 349	90%	10%
Pharr	US 281	61%	39%	Pharr	US 281	85%	15%
Wichita Falls	US 287	58%	42%	Wichita Falls	US 287	86%	14%
Average (ADT) =		62%	38%	Average (ADTT) =		80%	20%
Min (ADT) =		55%	21%	Min (ADTT) =		68%	10%
Max (ADT) =		79%	45%	Max (ADTT) =		90%	32%

Example - Equipment Information Sheet

Air Coupled Ground Penetrating Radar (GPR)

1 GHz antenna

General Description

- Vehicle mounted 1GHz antenna that transmits pulses of radar energy into the pavement. The system has an integrated high definition video logging system to provide images to complement the GPR data.
- Collects data at highway speeds. Traffic control is typically not required.

Measured Properties

- The antenna transmits electro-magnetic radar waves into the pavement at a frequency of 1 GHz. These waves are reflected at significant pavement layer interfaces and the system captures and displays these reflections as a plot of return voltage versus arrival time.
- Effective depth of penetration is 20 inches.

Data Analysis

- The software, PaveCheck, was developed by the Texas A&M Transportation Institute to assist with data analysis. The program integrates a video with a color plot of the waveforms. The program allows the user to:
 - Find anomalies visually.
 - Calculate layer thicknesses.
 - Calculate layer dielectric values.
 - Estimate locations of subsurface defects and the limits of the defects.
 - Estimate variations in surface density and the presence of subsurface moisture.

Benefits for Accelerated Construction

- Forensic investigations of existing pavement structures to help determine the appropriate maintenance or rehabilitation strategy.
- Engineers can make timely decisions due to the ease of data collection and analysis.

Limitations and Availability

- Some materials, such as light weight or slag aggregate, will give false positive indications of potential problem areas.
- The need for pavement coring is not eliminated; however, GPR data is helpful when developing a strategic coring plan.
- Experienced personnel needed to collect and analyze data.
- TxDOT currently owns 5 antennas.



Researcher Contact Information

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