

# Guides for System to Render M-E Traffic Data for Pavement Design: Student Guide

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Cooperative Research Program

# TEXAS A&M TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS

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# GUIDES FOR SYSTEM TO RENDER M-E TRAFFIC DATA FOR PAVEMENT DESIGN

#### **Student Guide**

by

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This report is not intended for construction, bidding, or permit purposes. The researcher in charge of the project was Lubinda F. Walubita.

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# LIST OF SYMBOLS AND NOTATIONS

AADTT	Average annual daily truck traffic
ADT	Average daily traffic
ALD	Axle load spectra data
ALDF	Axle load distribution factor
ATHWLD	Average ten heaviest wheel loads daily
CRCP	Continuously reinforced concrete pavement
DC	Dry-cold
DW	Dry-wet
EB	Eastbound
HDF	Hourly distribution factor
ESAL	Equivalent single axle load
FPS	Flexible pavement system
Gr	Growth rate
GVW	Gross vehicle weight
LEF	Load equivalency factor
LS	Load spectra
Μ	Moderate
MAF	Monthly adjustment factor
M-E	Mechanistic empirical
NB	Northbound
OV	Overlay
OW	Overweight
PTT	Pneumatic traffic tube
SB	Southbound
T-DSS	Traffic data storage system
TP&P	Transportation planning and programming
TTI	Texas A&M Transportation Institute
TxACOL	Texas asphalt concrete overlay design
TxDOT	Texas Department of Transportation
TxME	Texas Mechanistic-Empirical pavement design
VCD	Vehicle classification distribution
WB	Westbound
WC	Wet-cold
WIM	Weigh-in-motion
WW	Wet-warm

# SECTION I. INTRODUCTION

This guideline is to demonstrate and provide the key findings of Texas Department of Transportation (TxDOT) Project 0-6940 *Develop System to Render Mechanistic-Empirical Traffic Data for Pavement Design*. It can be used as a guide for rendering the traffic data required for FPS and mechanistic-empirical (ME) pavement designs for TxDOT engineers. This guide is to understand, mainly:

- Traffic data sources to obtain the applicable M-E traffic data
- Traffic data parameters calculated and generated using the collected traffic data such as traffic volume, speed, classification, and weight data
- Traffic data inputs required for pavement design (for FPS and ME design software)
- The traffic data storage system (The T-DSS) to store and provide ME-compatible traffic data support
- Data analysis macros to automatically analyze and generate the ME-compatible traffic data

# SECTION II. TRAFFIC DATA SOURCES

In order to develop traffic data clusters, the traffic data should be assembled from available permanent traffic data collectors and supplemented with portable collectors from sites lacking permanent collector stations. Also, easy-to-obtain traffic data (e.g., pneumatic tube volume-classification data) were collected to aid in validating the clustering algorithms where needed and on selected highways.

### TRAFFIC DATA PARAMETERS AND COLLECTORS

For the Project 0-6940, various types of traffic data were measured, collected, and assembled from three traffic data sources, namely: (a) permanent weigh-in-motion (WIM) stations, (b) portable WIM units, and (c) pneumatic traffic tube (PTT) counters. As indicated in Figure 1, the permanent and portable WIM systems provide the following minimum type of traffic data:

- Traffic volume counts
- Vehicle classification
- Vehicle speed
- Vehicle weights, i.e., gross vehicle weight (GVW)
- Axle load spectra data
- Number of axles
- Individual axle loads
- Axle spacing

a)	Permanent		Traffic Data Type	Traffic Parameter	Permanent WIM	Portable WIM	Pneumatic Traffic Tube (PTT)Counters
	WIM stations			Average Annual Daily Traffic (AADT)	$\checkmark$	$\checkmark$	$\checkmark$
	(2013-2016)		Traffic Volume	Average Annual Daily Truck Traffic (AADTT)	$\checkmark$	$\checkmark$	$\checkmark$
	<b>D</b>		Traffic Volume	Truck percentage	$\checkmark$	$\checkmark$	$\checkmark$
b)	Portable WIM	said 2		Axles per truck	$\checkmark$	$\checkmark$	
	stations		Classification	Vehicle Classification Distribution (VCD)	$\checkmark$	$\checkmark$	$\checkmark$
			Vehicle Speed	Vehicle speeds (mph)	$\checkmark$	$\checkmark$	$\checkmark$
			Adjustment	Monthly Adjustment Factors (MAF)	$\checkmark$		
c	Pneumatic		Factors Hourly Distr	Hourly Distribution Factors (HDF)	$\checkmark$	$\checkmark$	$\checkmark$
C)	traffic tube		Growth Rate	Yearly Volume Growth Rate (Gr)	$\checkmark$		
	(PTT)			Gross Vehicle Weight (GVW)	$\checkmark$	$\checkmark$	
	counters	E.	Weight	Axle Load Distribution Factors (ALDF) or Axle Load Spectra (ALS)	$\checkmark$	$\checkmark$	

Figure 1 Type of Traffic Source and Collected Data.

In addition to the detailed per vehicle measurements, the WIM systems also provide traffic volume and vehicle classification data including the per hour number of vehicles for different vehicle classes. The permanent WIM data are obtained continuously during the year while the portable WIM data are obtained during the short-term deployment periods, which is at minimum seven consecutive days up to 1-year with routine periodic service maintenance. Unlike the WIM systems that also measures vehicle weights, pneumatic tube counters are installed to measure and collect only traffic volume counts, vehicle speed, axle spacing, and vehicle classification for at least 48-hours up to 7-days – but with no vehicle weight data.

### TRAFFIC STATIONS AND HIGHWAY SITES

As mentioned above, the traffic data include permanent WIM, portable WIM, and pneumatic traffic tube counter data from a combined total of 59 stations/sites as presented in Figure 2. All the permanent WIM data were obtained from TxDOT's Transportation Planning and Programming (TP&P) division. The portable WIM data were measured and collected by Texas A&M Transportation Institute (TTI) through the short-term (minimum 7-days thru to 1-year) deployment of portable WIM units on selected highway sites around the State. Likewise, the pneumatic traffic tube data were also measured and collected by TTI through the short-term (minimum 48-hrs thru to 7-days) deployment of pneumatic traffic tube counters.

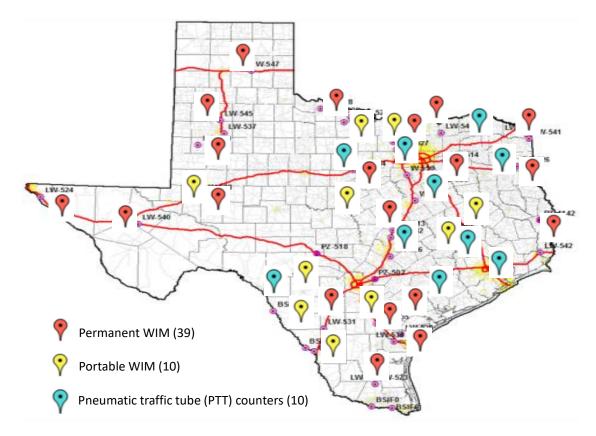


Figure 2 Location of WIMs and PTT Sites for Traffic Data Collection.

Table 1 lists an example of the site information where permanent WIM, portable WIM, and PTT counters were installed to obtain the traffic data.

No.	Station ID	District(County)	Climate	HWY	Direction	RM	GPS
	nanent WIM	· · · · · · · · · · · · · · · · · · ·	Cilliate	11 11 1	Direction	<b>N</b> <sub>1</sub> <b>N</b> <sub>1</sub>	015
1	W513	Waco (Bell)	М	IH 35	All (NB & SB)	276-280	N 30° 51' 36" W 97° 35' 18"
2	W523	Pharr (Hidalgo)	М	US 281	All (NB & SB)	750-748	N 26° 41' 09" W 98° 06' 53"
3	W524	El Paso (El Paso)	DW	IH 10	All (EB &WB)	40-41	N 31° 37' 59" W 106° 13' 08"
4	W527	Fort Worth (Wise)	WC	SH 114	All (NB & SB)	582	N 33° 02' 11" W 97° 25' 56"
5	W531	Laredo (La Salle)	DW	IH 35	All (NB & SB)	50-55	N 28° 13' 05" W 99° 18' 10"
6	W534	Corpus Christi (Nueces)	М	IH 69	All (NB & SB)	145	N 27° 50' 23" W 97° 37' 59"
7	W541	Atlanta (Cass)	WC	FM3129	NB & SB (L1)	232-230	N 33° 13' 32" W 94° 05' 56"
8	W542	Beaumont (Orange)	WW	IH 10	All (EB &WB)	860-865	N 30° 07' 35" W 94° 01' 25"
9	W547	Amarillo (Potter)	DC	IH 40	All (EB & WB)	110-120	N 35° 11' 39" W101° 04' 26"
Port	able WIM Sit			-			-
1	TS001	Laredo (Webb)	DW	US 83	NB (L1)	678-680	N 28° 02' 37" W 99° 32' 60"
2	TS002	Bryan (Robertson)	WW	SH7	All (EB & WB)	618-616	N 31° 15' 27" W 96° 21' 09"
3	TS003	Bryan (Leon)	WW	SH7	WB (L1)	658-660	N 31° 18' W 95° 35'
4	TS007	Fort Worth (Wise)	WC	SH 114	EB (L1)	582-584	N 33°02' W 97°25'
5	TS004	Laredo (Dimmit)	DW	FM 468	EB (L1)	432-434	N 28°33' W 99°30'
6	TS005	Corpus Christi (Live Oak)	М	US 281	NB & SB (L1)	620-622	N 28°27'59" W 98°10'51"
7	TS006	Beaumont (Comanche)	DW	SH 6	NB-L1	386-384	N 32°13' W 98°57'
8	TS008	Odessa (Midland)	DW	FM 1787	All (EB & WB)	280	N 31°41' W 102°07'
9	TS009	Laredo (Webb)	DW	US 83	NB (L1)	696-698	N 27°46' 46" W 99° 27' 00"
	umatic Traffic						N 000 101 05 0"
1	TTI00001	Atlanta (Panola)	WC	US 59	SB (L1)	308-310	N 32° 12' 05.3" W 94° 20' 35.5"
2	TTI00051	Austin (Bastrop)	M	SH 304	SB	450-452	N 30° 06' 06.8" W 97° 21' 08.5" N 29° 22' 34.6"
3	TTI00024	Yoakum (Lavaca)	WW	SH 95	SB	522-524	W 97° 09' 52.0"
4	TTI00002	Fort Worth (Wise) Laredo	WC	SH 114	EB (L1)	582-584	N 33° 02' 12.1" W 97° 25' 34.5" N 28° 40' 58.9"
5	TTI00005 TTI00016	(Maverick)	DW	Loop 480	SB & NB (L1)	570-567	W 100° 30' 10"
6		Houston (Harris) Paris	WW	FM 2100	NB & SB	456-454	N 29° 55' 32.6" W 95° 04' 18.2" N 33° 51' 06.5"
7	TTI00007	Paris (Lamar) San Antonio	WC	US 271	NB & SB	187-188	N 33° 31' 06.5" W 95° 30' 33.2" N 29° 42' 34.8"
8	TTI00019 TTI00009	San Antonio (Comal) Waco	DW	IH 35 IH 35F	SB (L1)	190-189	N 29° 42' 34.8" W 98° 05' 23.8" N 30° 58' 25.90"
ソ	1 1 100009	(Bell)	М	IH 35F	NB & SB	269-268	W 97° 30' 55.2"

Table 1 Example of Permanent WIM Stations, Portable WIM Sites, and PTT Sites.

Legend: DC=dry-cold; DW=dry-warm; M=moderate; WC=wet-cold; WW=wet-warm; EB=eastbound; NB=northbound; SB=southbound; WB=westbound

# SECTION III. TRAFFIC PARAMETERS AND EXAMPLE RESULTS

As described in Section II, traffic data were collected and assembled for 59 stations/sites including 39 permanent WIM, 10 portable WIM, and 10 pneumatic traffic counter sites. The statewide WIM traffic data were processed, analyzed, and evaluated under Task 2 of this project, namely: Task 2 – Collection and Assembly of Statewide Traffic WIM Data. The analytical approaches used, the results, and key findings of the project are reported in this section.

### TRAFFIC DATA ANALYSIS AND RESULTS

Based on the WIM traffic volume, speed, classification, and weight data, the pertinent traffic parameters were calculated. The computed/generated traffic parameters are useful traffic inputs for designing, planning, and monitoring highways infrastructures. As a minimum and as listed in Figure 1, the calculated traffic parameters include the following:

- Average daily traffic (ADT), which is computed as the total number of vehicles (all classes) recorded divided by the duration of record (i.e., number of days).
- Average daily truck traffic (ADTT), which is calculated as the total number of trucks (FHWA vehicle class 4-13) recorded divided by the duration of record (i.e., number of days) (Figure 3).
- Percentage of truck (%truck) = ADTT/ADT (%).
- Vehicle class distribution (VCD), the percentage of each vehicle class in the ADT.
- Average vehicle speed and the percentage of over-speeding vehicles estimated relatively to the speed limit at the highway section in question.
- Axle per truck inputs, computed as the average number of single/tandem/tridem/quad axles per truck.
- Total 20-years' and 30-years' 18-kips ESALs, estimated using the load spectra of trucks and the annual traffic growth rate.
- Average ten heaviest wheel loads daily (ATHWLD).
- Daily gross vehicle weight (GVW) distribution, the daily single/tandem/tridem/quad load distribution.
- Daily overweight vehicles estimated based on the recorded GVW values and the consideration of 80 kips as the limit allowed for GVW.
- Daily overweight axles, estimated based on the different axle threshold loads, e.g., 20kips for single axles, 34-kips for tandem axles, 42-kips for tridem axles, and 50-kips for quad axles.
- Axle load distribution (ALD), estimated through the load spectra (LS) analysis.

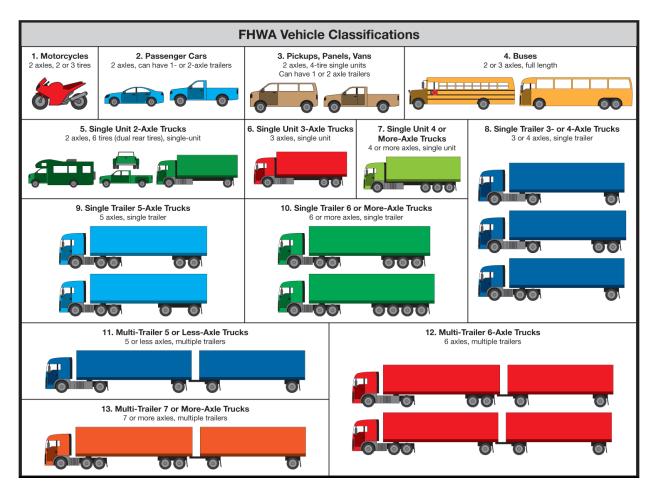


Figure 3 FHWA Vehicle Classification.

For the LS data analysis, the weight data for each axle category (i.e., steering, other single, tandem, tridem, and quad) are addressed separately for each truck classification from Class 4 to 13. The results are reported for individual months of the year (i.e., from January to December) and then, organized to generate the ALD input files for the M-E software including TxME, M-E PDG, and AASHTOWare. Along with the traffic parameters, historical traffic volume data, predominantly permanent WIM data, were utilized to compute the monthly adjustment factors (MAF) and the annual traffic growth rate (Gr). In general, the latest three consecutive year's traffic volume data are needed to accurately generate the MAF and Gr data for a given highway section. In the event this minimum 3-years' data requirement is not met, then default values are used such as 3% for Gr. Among others, the LS estimates are useful for designing and quantifying the damage on pavement structures. Hence, the study provides 18-kip ESAL estimates for both flexible and concrete pavements.

# TRAFFIC DATA FOR PAVEMENT DESIGN: FPS AND M-E TRAFFIC INPUTS

Based on the analysis of WIM and PTT traffic data, pertinent traffic parameters and inputs were calculated and provided for pavement design using FPS and M-E design software as listed in Table 2.

General Traffic Data	Pavement Design Software
<ul> <li>Volume counts (ADT, ADTT, %Trucks, etc)</li> <li>Vehicle speed</li> <li>Vehicle classification</li> <li>Hourly &amp; daily distributions</li> <li>Growth rates</li> <li>Vehicle weights</li> <li>Axle load distribution</li> <li>Overweight's &amp; overloading statistics</li> <li>ATHWLDs</li> <li>Load equivalency factor (LEF)</li> </ul>	<ul> <li>FPS</li> <li>TxCRCP-ME (concrete)</li> <li>TxM-E</li> <li>TxACOL</li> <li>TxCrackPro</li> <li>M-E PDG</li> <li>AASHTOWare</li> <li>PerRoad</li> </ul>

#### Table 2 General Traffic Data and Pavement Design Software.

Examples of traffic data analysis results are presented in the following tables and figures, including FPS/M-E inputs, WIM/PTT data, GVW/axle weight distribution data, truck overweight data, overloading statistics, WIM-PTT traffic data comparisons, and portable WIM accuracy.

#### FPS Input and Traffic Data from Permanent WIM

FPS Parameter	NB-L1 (Outside)	NB-L2 (Inside)	SB-L1 (Outside)	SB-L2 (Inside)	Comment
ADT-Beginning	6,113	2,699	6,213	2,656	ADT at the beginning of the design period
ADT-END 20 Year	23,001	10,155	23,377	9,994	ADT at the end of the design period (20 yrs)
18 kip ESALs 20 Years (millions)	39.08	5.49	40.11	5.76	@ 6.85% Gr
Avg. vehicle speed (mph)	~65	~65	~65	~65	Approach speed assumed to be equal to operational speed
% Trucks in ADT	47%	13%	51%	14%	
ATHWLD (kips)	14.3	11.8	12.3	12.7	
%Tandem axles	55.5%	51.1%	57.9%	54.9%	

### Table 3 FPS Traffic Input Data from Permanent WIM (Station W531, IH 35 near Cotulla).

Overload		Daily OW		% age number/count of OW axles			
Lane	ADTT	Trucks (>80 kips)	%OW	Single (>20kips)	Tandem (>34kips)	Tridem (>42kips)	Quad (>50kips)
SB-L1	1,968	98	5.0	2.0	8.0	21.3	40.0
EB-L1	3,432	77	2.2	0.5	7.8	16.9	0.0
EB-L1	1,670	333	19.9	1.0	33.0	90.5	58.3
NB-L1	2,400	144	6.0	0.8	7.9	20.0	34.8
NB-L1	192	70	36.5	0.5	41.5	4.9	0.0
WB-L1	2,400	159	5.9	1.3	12.0	91.8	0.0
	SB-L1 EB-L1 EB-L1 NB-L1 NB-L1	Lane         ADTT           SB-L1         1,968           EB-L1         3,432           EB-L1         1,670           NB-L1         2,400           NB-L1         192           WB-L1         2,400	ADTT         Trucks (>80 kips)           SB-L1         1,968         98           EB-L1         3,432         77           EB-L1         1,670         333           NB-L1         2,400         144           NB-L1         192         70           WB-L1         2,400         159	ADTTTrucks (>80 kips)%OWSB-L11,968985.0EB-L13,432772.2EB-L11,67033319.9NB-L12,4001446.0NB-L11927036.5WB-L12,4001595.9	ADTT         Trucks (>80 kips)         %OW         Single (>20kips)           SB-L1         1,968         98         5.0         2.0           EB-L1         3,432         77         2.2         0.5           EB-L1         1,670         333         19.9         1.0           NB-L1         2,400         144         6.0         0.8           NB-L1         192         70         36.5         0.5           WB-L1         2,400         159         5.9         1.3	ADTT         Trucks (>80 kips)         %OW         Single (>20kips)         Tandem (>34kips)           SB-L1         1,968         98         5.0         2.0         8.0           EB-L1         3,432         77         2.2         0.5         7.8           EB-L1         1,670         333         19.9         1.0         33.0           NB-L1         2,400         144         6.0         0.8         7.9           NB-L1         192         70         36.5         0.5         41.5           WB-L1         2,400         159         5.9         1.3         12.0	ADTT         Trucks (>80 kips)         %OW         Single (>20kips)         Tandem (>34kips)         Tridem (>42kips)           SB-L1         1,968         98         5.0         2.0         8.0         21.3           EB-L1         3,432         77         2.2         0.5         7.8         16.9           EB-L1         1,670         333         19.9         1.0         33.0         90.5           NB-L1         2,400         144         6.0         0.8         7.9         20.0           NB-L1         192         70         36.5         0.5         41.5         4.9           WB-L1         2,400         159         5.9         1.3         12.0         91.8

Table 4 Truck Overweight and Overloading Statistics from Permanent WIM.

*Legend*: OW = Overweight

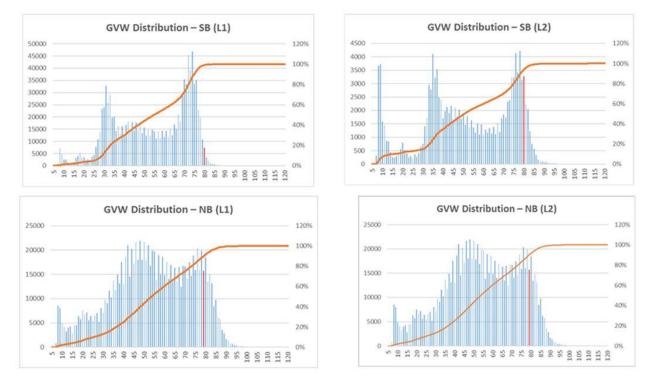


Figure 4 GVW Distribution of Station W531 (IH 35 near Cotulla).

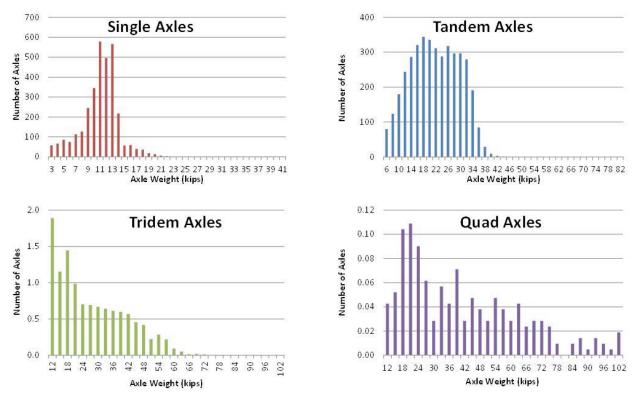


Figure 5 Axle Weight Distribution of W531 (IH 35 near Cotulla).

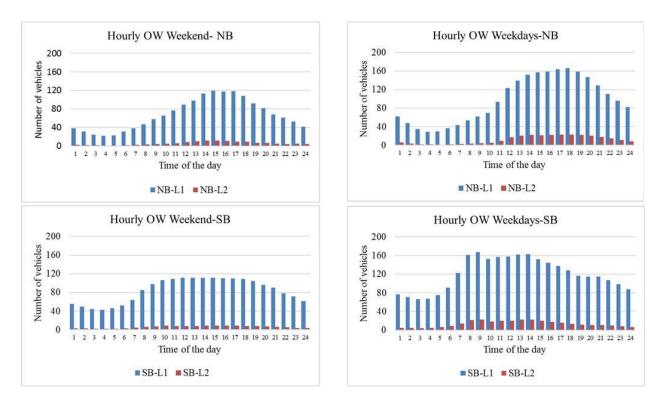
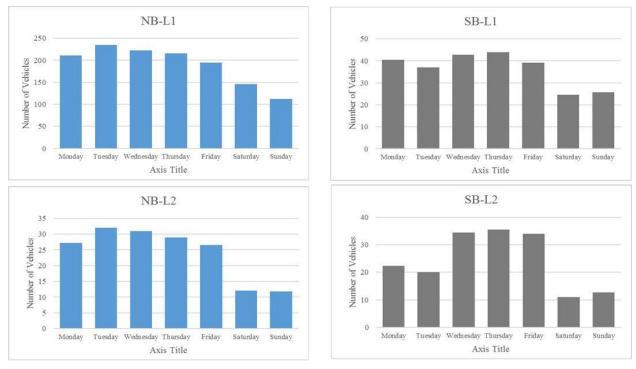
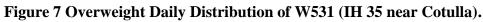
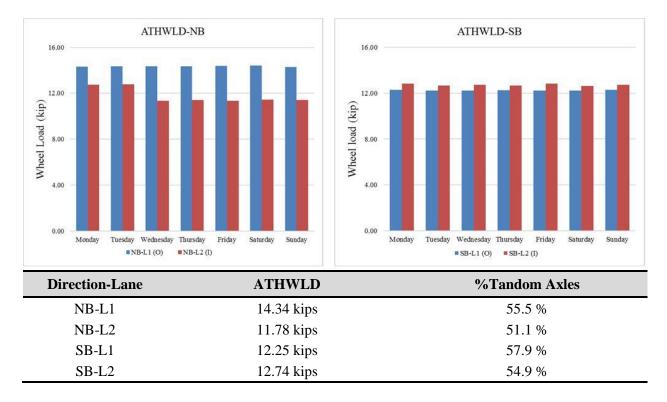


Figure 6 Overweigh Hourly Distribution of W531 (IH 35 near Cotulla).









#### **M-E Input Data from Portable WIM**

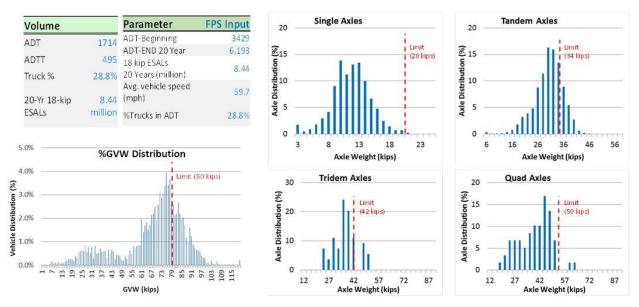


Figure 9 General M-E Traffic Data Collected using Portable WIM (US 83 NB in Laredo).

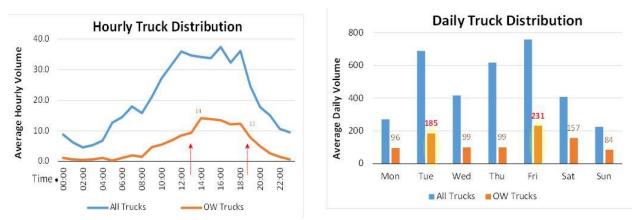


Figure 10 Hourly and Daily Truck Distributions from Portable WIM (US 83 NB Laredo).

# SECTION IV. THE TRAFFIC DATA STORAGE SYSTEM

The M-E traffic data storage system (T-DSS) was developed, being maintained and managed in the user-friendly MS Access platform to provide M-E traffic data support for the FPS and other M-E software such as the TxME. The Microsoft Access<sup>®</sup> is compatible with most computer machines and almost all the engineering professionals are conversant with MS office/access; hence, this was selected as the platform for the T-DSS. As shown in Figure 11, the data are arranged and stored in tabular format along with zipped attachments such as MAF and ALD files. As shown in Figure 11, the main traffic data tables are:

- Tables 01-03: Traffic volume and classification data.
- Table 04: FPS input data.
- Table 05: TxME input data.
- Table 06: TxACOL and TxCrackPro data.
- Table 07: M-E PDG and AASHTOWare input data.

🖬 🗇 🐨 🗧 11. The Prototype T-DSS_Project 0-69	40_Version011 - Added help function : Database- E:\T-DSS\11. The Prototype T-DSS_Project 0-6940_Vers ? – 🛛 🗸 👘
File Home Create External Data Database	Tools 🛛 Q Tell me what you want to do Prakoso, Adrianus
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Search	TxDOT Project 0-6940
Screen *	The Taura M E Traffic Data Stars - Sustan Dusing the COMO
"᠍ Screen(Switchboard) Traffic Volume & Classification ☆	The Texas M-E Traffic Data Storage System Project# 0-6940:
Table01_Traffic Volume, ESALs, & Vehicle Speed Data	The T-DSS
🚛 Table02_ADT, ADTT, & Vehicle Classification Data	MELP
Table03_Traffic Volume Distribution (Daily & Hourly)	
FPS & TxM-E Traffic Input Data	EXIT
Table04_FPS Input Data	Traffic Volume/ESALs
Table05a_TxME Input Data (Level1 - General)	
Table05b_TxME Input Data(Level1-ClassDistribution	FPS Traffic Input Data
Table05c_TXME Input Data (Level2-Basic Data)	TxME Traffic Input Data-Level1
Table06_TXACOL & TxCrackPro Input Data	Texas
Table07b_AASHTOWare PVMNT Input Data (Level 1)	Department III TxME Traffic Input Data-Level2
Traffic Weights & Overloading Data	of Transportation
Table08_Traffic Weight Data	
Table09a_Overloading Overweight Data Statistics	
Table09b_Overloading Overweight Data Statistics	
Table09c_ Overweight Distribution (GVW and Axles)	Project Managers: Sonya Badgley, Hua Chen, and Enad Mahmoud
Table09d_ Overweight Distribution (GVW and Axles)	Texas Transportation
* Table09e_ Overweight Distribution (Daily and Hourl	PI/Research Supervisor: Lubinda F.Walubita
Table09f_ Overweight Distribution (Daily and Hourl	
Table10_Load Equivalent Factors (LEFs)	
Sensitivity & Error Analysis 🕆	
Table11_WIM Sensitivity & Error-Accuracy Analysis D	
Supplementary Data , Table12_FHWA Vehicle Classification System	
Table13_FHWA Weight Classification	
Form View	Record: M < 1 of 1 >> N >> T No Filter Search Num Lock 🔳 🔝 🔛



### FPS TRAFFIC INPUT DATA

FPS is the primary software that is routinely used by TxDOT for the design of flexible pavements. Figure 12Figure 13 show the main FPS21 and traffic-data input screens, respectively. Table 5 and Figure 14 lists the specific FPS21 traffic data inputs and the data source from the T-DSS.

21 Main Menu	
TEXAS FLEXIBLE PAVEMENT	DESIGN SYSTEM
📂 FPS 21	FPS Pavement Design
Ver: FPS21, V1.3, Released:7-1-2015	Stress Analysis Tool
	Product Disclaimer
	Exit

Figure 12 Main FPS Screen.

but Design Data			
Basic Design Criteria		Traffic Data	
LENGTH OF ANALYSIS PERIOD, (Year)	20	ADT, BEGINNING (VEH/DAY)	4500
MIN TIME TO FIRST OVERLAY, (Year)	10	ADT, END 20 YR (VEH/DAY)	7000
MIN TIME BETWEEN OVERLAYS, (Year)	3	18 kip ESAL 20 YR (1 DIR) (millions)	10.000
DESIGN CONFIDENCE LEVEL 95.0%	C÷	AVG APP. SPEED TO OV. ZONE (mph)	70.
INITIAL SERVICEABILITY INDEX	4.5	AVG SPEED, OV. DIRECTION (mph)	45.
FINAL SERVICEABILITY INDEX	3	AVG SPEED, NON-OV. DIRECTION (mph)	50.
SERVICEABILITY INDEX AFTER OVERLAY	4.2	PERCENT ADT/HR CONSTRUCTION (%)	6.0
DISTRICT TEMPERATURE CONSTANT ('F)	31	PERCENT TRUCKS IN ADT (%)	6.7
INTEREST RATE (%)	7.0		
Program Controls			
MAX FUNDS /SQ. YD, INIT CONST	99.0		
MAX THICKNESS, INIT CONST	69.0		
MAX THICKNESS, ALL OVERLAYS	6.0	To Main Menu	

Figure 13 FPS Traffic-Data Input Screen.

As illustrated in Table 5 and Figure 14, the traffic input data required for the FPS21 software are contained in Table04 of the T-DSS, namely "Table04\_FPS Input Data." These data are visually/manually accessed from the T-DSS and manually entered into the FPS software.

No.	Input Data	Data Source/ Location in the T-DSS
1	ADT begin (veh/day)	
2	ADT end 20 Yr (veh/day)	
3	18 kip ESALs 20 Yr – 1 Direction (millions)	
4	Avg. App. Speed to Overlay (OV) Zone	Table04_FPS Input Data
5	Avg. Speed OV & Non-OV Direction	
6	Percent ADT/HR Construction	
7	Percent trucks in ADT	

 Table 5 List of Main Traffic Data Input for FPS.

Custom 💿	~	1	Table04_FPS Inp	ut Data						
Search	ρ		ADTbegin 👻	ADTend-20Y -	20Yr 18-kips 🔻	Avg Vehicle Speed (mph) 🕶	%Trucks in ADT 👻	ATHWLD (kips) 🝷	ATHALD (kip: -	%age Tander 🔻
			6113	23001	. 39.08	65.0	47.00%	14.34	28.68	55.50%
Screen	*		2699	10155	5.49	65.0	13.00%	11.78	23.56	51.06%
" 🕄 Screen(Switchboard)			6213	23377	40.11	65.0	51.00%	12.25	24.50	57.91%
Traffic Volume & Classification	×		2656	9994	5.76	65.0	14.00%	12.74	25.48	54.87%
FPS & TxM-E Traffic Input Data	\$		2124	6473	1.79	65.0	14.00%	13.03	26.06	46.84%
·			2150	6552	1.69	65.0	17.00%	12.86	25.73	46.73%
Table04_FPS Input Data			504	910	0.44	65.0	33.00%	12.8	25.62	60.12%
			1902	3435	5.31	67.1	20.50%	15.5	30.90	49.12%
Table05a_TxME Input Data (Level1 - Gener	aı)		1977	3571	. 12.74	64.8	54.00%	15.5	30.90	57.78%
Table05b_TxME Input Data(Level1-ClassDi	etr		1354	2445	37.31	33.7	77.00%	20.51	41.01	56.42%
and rabieosb_txme input bata(ceveri-classor	50		3801	6865	18.90	35.2	32.00%	15.29	30.57	56.15%
Table05c_TxME Input Data (Level2-Basic D	ata)		2118	3825	2.25	69.0	22.40%	12.68	25.37	45.61%
<b>x</b>	,		6113	23001	. 39.08	65.0	47.00%	14.34	28.68	55.50%
"III Table06_TxACOL & TxCrackPro Input Data			2699	10155	5.49	65.0	13.00%	11.78	23.56	51.06%
			6213	23377	40.11	65.0	51.00%	12.25	24.50	57.91%
Table07a_M-E PDG Input Data (Level1)			2656	9994	5.76	65.0	14.00%	12.74	25.48	54.87%
			2675	4831	8.85	65.4	33.80%	16.29	32.58	49.20%
Table07b_AASHTOWare PVMNT Input Dat	ta (		2623	4737	7.99	64.7	30.20%	11.53	23.06	48.96%

#### Figure 14 Table04 in the T-DSS.

# TXCRCP-ME AND CONCRETE TRAFFIC INPUT DATA

TxCRCP-ME, an algorithm in Microsoft Excel macro format, is one of the commonly used routine methods by TxDOT for designing concrete pavements. As shown in Figure 15, the key required traffic input parameters are the number of lanes and the 30-year 18-kip ESALs in one direction. As listed in, these two parameters are sourced from Table 6 in the T-DSS, namely "Table01\_Traffic Volume, ESALs, and Vehicle Speed Data." As exemplified in Figure 16, the data are accessed visually/manually but with future plans for automated export into the TxCRCP-ME program as both the TxCRCP-ME program and the T-DSS are based on the MS Excel platform.

CRCP DESIGN PROGRAM BA	SED ON MECH	IANISTI	C-EMPIF	RICAL PRINCIP	LES		
Developed ur	der TxDOT Rese	arch Proje	ect 0-5832				
V	ersion: <u>TxCRCP-N</u>	1E v07b					
A. Project Identification			D. Concre	ete Layer Informati	on		
District			Thickness	of Concrete Layer (i	in.)		
County				odulus of Rupture (p		570	
Highway					/		
CŠJ							
Direction			E. Suppo	rt Layers Informati	on		
Station (Begin)			••	•			
Station (End)			Soil Class	ification System	U	SCS	
				ification of Subgrade	•		
			Base Type			СТВ	
B. Design Parameters			Base Thic	kness (in.)		6	
			Modulus o	f Base Layer (ksi)			
Design Life (year)	30						
Number of Punchouts per Mile	10		Composite	e K (psi/in.)		0	
C. Design Traffic							
Total Number of Lanes in One Direction							
Total Design Traffic in One Direction (million ESALs)							
Input Temperature Soil Classification K-Tab	le Composite K	S-Table	Stress	Analysis Result	Final Result	Time v	. Punchout

Figure 15a. Main MS Excel Worksheet for the TxCRCP-ME.

Concrete - Inputs (Based on Concrete Daily ESAL)	NB-L1	NB-L2	SB-L1	SB-L2 Comment
Design Life	30	30	30	30 Years
Annual Growth Rate	6.72	6.72	6.72	6.72 %
Number of Lanes in one direction	2	2	2	2
18 kip ESALs 30 Years (million)	221.53	26.20	168.20	14.99

# Figure 15b. Example TxCRCP-ME Inputs for Station W531 (IH 35, Cotulla, LRD District).

### Table 6 List of Main Traffic Data Input for TxCRCP-ME.

No.	Input Data	Data Source/ Location in the T-DSS
1	Number of lanes in one direction	Table01_Traffic Volume, ESALs, and Vehicle Speed Data
2	30-year 18-kip ESALs in one direction	Tableo1_TTaffic Volume, ESAEs, and Venicle Speed Data

Tabl	e01_Traffic V	olume, ESAI	s, & Vehicle Speed Data	a				
_ HWY	🗸 👻 LaneD	irection 👻	LaneDesignation -	NoOfLanesIn -	Year 👻	Estimated 20-Yr 18-	kip ES 👻	Estimated 30-Yr 18-kip ESALs (Millions) -
IH 35	NB		Outside (L1)	2	2015		39.08	70.18
IH 35	NB		Inside (L2)	2	2015		5.49	9.15
IH 35	SB		Outside (L1)	2	2015	40.11		78.01
IH 35	SB		Inside (L2)	2	2015		5.76	
								-
District	County	HWY	LaneDirection	LaneDesignation	NoOf	LanesInOneDirection	Year	Estimated 30-Yr 18-kip ESALs (Millions)
Laredo	La Salle	IH 35	NB	Outside (L1)		2.00	2015	70.18
Laredo	La Salle	IH 35	NB	Inside (L2)		2.00	2015	9.15
Laredo	La Salle	IH 35	SB	Outside (L1)		2.00	2015	78.01
Laredo	La Salle	IH 35	SB	Inside (L2)		2.00	2015	9.24

Figure 16 TxCRCP-ME Traffic Input Data (T-DSS and Excel-Export Tables).

#### TXACOL AND TXCRACKPRO TRAFFIC INPUT DATA

TxACOL and TxCrackPro software are overlay design and M-E analysis programs. Figure 17 shows the main software screens. The basic traffic input data requirements are listed in Table 7 along with data source location in the T-DSS, namely Table06 (i.e., Table06\_TxACOL and TxCrackPro Input Data; see Figure 18). Data export from the T-DSS to both these two M-E software is visual/manual based. Automated data import will require interfacial modules as the T-DSS and the software use different code platforms. Both the two M-E software were developed at TTI along with the T-DSS. Therefore, exploring for a bridging module to allow for automated data export/import is feasible.

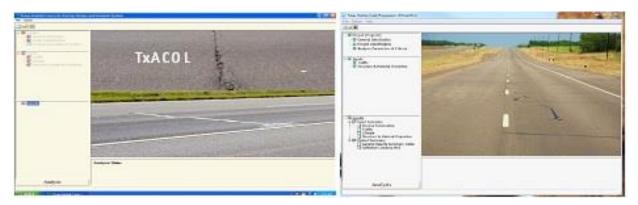


Figure 17 Main Screens for TxACOL and TxCrackPro.

#### Table 7 List of Main Traffic Data Inputs for TxACOL and TxCrackPro.

No.	Input Data	Data Source/ Location in the T-DSS
1	ADT begin (veh/day)	
2	ADT end 20 yr. (veh/day)	Table06_TxACOL and TxCrackPro Input Data
3	18 kip ESALs 20 yr1 Direction (millions)	
4	Operation speed (mph)	

Custom 💿	~		OL & TxCrack							
Search	Q	_ District +	County -	HWY	<ul> <li>Lane Directic +</li> </ul>	Lane Designa 🕶	ADTbegin 🝷	ADTend-20Yr 👻	20Yr 18-kips ESALs (million) +	Operational Speed (mph) +
Screen ¥		Laredo	Webb	US 83	NB	Outside	3520	6357	8.31	60.2
Traffic Volume & Classification *	÷.	Laredo	Webb	US 83	NB	Oustide	3506	6332	8.89	61.7
frame volume & classification A		Laredo	La Salle	IH 35	NB	Outside (L1)	6113	23001	39.08	65.0
Table01_Traffic Volume, ESALs, & Vehicle .	- 1	Laredo	La Salle	IH 35	NB	Inside (L2)	2699	10155	5.49	65.0
		Laredo	La Salle	IH 35	SB	Outside (L1)	6213	23377	40.11	65.0
Table02_ADT, ADTT, & Vehicle Classificati		Laredo	La Salle	IH 35	SB	Inside (L2)	2656	9994	5.76	65.0
-		Bryan	Robertson	SH 7	WB	Outside	1880	3396	3.47	69.8
Table03_Traffic Volume Distribution (Dail_		Bryan	Robertson	SH 7	EB	Outside	2108	3807	4.61	66.9
FPS & TxM-E Traffic Input Data 🛛 🛠		Bryan	Robertson	SH 7	WB	Outside	2510	4533	6.07	68.9
Table04_FPS Input Data		Bryan	Robertson	SH 7	EB	Outside	2538	4584	6.31	66.6
		Laredo	Dimmit	FM 468	EB	Outside(L1)	1977	3571	12.70	64.8
Table05a_TxME Input Data (Level1 - Gene		Odessa	Midland	FM 1787	SB	Outside(L1)	2675	4831	8.85	65.4
		Odessa	Midland	FM 1787	SB	Outside(L1)	2623	4737	7.99	64.7
Table05b_TxME Input Data(Level1-ClassD_		Fort Worth	Wise	SH 114	EB	Outside (L1)	4802	23571	39.38	65.0
		Fort Worth	Wise	SH 114	EB	Inside (L2)	3236	15884	8.80	65.0
Table05c_TxME Input Data (Level2-Basic		Fort Worth	Wise	SH 114	WB	Outside (L1)	4378	21490	37.31	65.0
		Fort Worth	Wise	SH 114	WB	Inside (L2)	2844	13960	6.87	65.0
Table06_TxACOL & TxCrackPro Input Data		Fort Worth	Wise	SH 114	EB	Outside (L1)	5800	10476	38.69	67.0
		Brownwood	Comanche	SH 6	NB	Outside(L1)	1862	3362	3.76	68.3
Table07a_M-E PDG Input Data (Level1)		Laredo	Dimmit	FM 468	EB	Outside(L1)	1380	2493	13.50	59.4
		Amarillo	Potter	IH 40	EB	Outside (L1)	4774	11759	49.67	70.0
Table07b_AASHTOWare PVMNT Input Da.		Amarillo	Potter	IH 40	EB	Inside (L2)	1140	2808	5.47	70.0
Traffic Weights & Overloading Da ¥		Amarillo	Potter	IH 40	WB	Outside (L1)	4722	11754	43.44	70.0

Figure 18 TxACOL and TxCrackPro Traffic Input Data in The T-DSS (Table06).

### **TXME TRAFFIC INPUT DATA**

TxME is an M-E based software used for the design, structural analysis, and performance predictions of flexible pavements. Figure 19 illustrates the TxME screen for traffic input (Level 2). Table 8 lists the main traffic data inputs for the TxME by the traffic input levels along with the source location from the T-DSS. Data access is visual/manually based with the need for an interface module to facilitate automated data export/import between the T-DSS and TxME.

Project 🔛 Option	🏟 Run 🚆 Help							X
🖾 Poject 🖾 Option								
TxME Explorer # ×		Project1:Traffic*	Project1:Reliability*					<del>.</del> ×
Projects     Project1	Traffic Input				Vehicle Cla	ss Distribution	and Growth	
<ul> <li>Frojecti</li> <li>Structure</li> <li>Climate</li> <li>Traffic</li> </ul>	Clevel 2: ESALs	Evel 1	: Load Spectra		Vehicle Pir Class Vie	ctorial Distributio	Growth Rate (%) Growth Function	
Reliability	Level 1: Load Spectra	Class 4	1.8		•			
	General Traffic Information		Axle Configuration		Class 5	24.6	4 Co	•
			Axle Tire		Class 6 @	7.6	4 Co	•
	Annual Average Daily Truck Traffic	500	Single Tire Pressure (psi): Dual Tire Pressure (psi):	100 100	Sum of Distribution (%):		b): 100	100.0
	Percent in Design Direction (%):	50	Dual Tire Spacing (in):	12				
	Percent in Design Lane (%):	95.0	Axle spacing		Axles Per Truck			
	Operational Speed (mph):	60	Tandem Axle (in): Tridem Axle (in):	51.6 49.2	Vehicle Class	Steering Axle	Ot Ta Tri Q he nd de ua r e m d	a 🛙
			Quad Axle (in):	49.2	Class 4	0	1 0 0 0	
					Class 5	0	2 0 0 0	
			Axle Load Distribution		Class 6	0	100	-
			Fore Load Disarbacon		Note: Steeri	ng Axle Single	axle, single tire	; o

Figure 19 TxME Traffic Input Screen.

#### Table 8 List of Main Traffic Data Input (by Level) for TxME.

Level	Input Data	Data Source/ Location in the T-DSS
1	Tire Pressure (psi) ADT Beginning (Veh/Day) ADT-End 20 YR (Veh/Day) 18 kip ESALs 20 YR (1 DIR, million) Operation Speed (mph)	Table05c_TxME Input Data (Level2-Basic Data)
2	General Traffic Information         Traffic 2-Way AADTT         No. of lanes in design direction         % of trucks in design direction         % of trucks in design lane         Operation speed	Table05a_TxME Input Data (Level1-General)
	Axle Configuration         Axle tire (Single & dual tire pressure)         Axle Spacing (Tandem/Tridem/Quad)	Table05a_TxME Input Data (Level1-General)
	MAF and ALD files	Table05a_TxME Input Data (Level1-General) – under attachments
	Axle load distribution Vehicle class distribution and growth Axle per truck	Table05b_TxME Input Data (Level1-Class Distribution and Axles Per Truck)

#### MEPDG/AASHTOWARE ME PAVEMENT ME DESIGN TRAFFIC INPUT DATA

Similar to the TxME, the M-E PDG and AASHTOWare Pavement ME Design are M-E based software used for the design, structural analysis, and performance predictions of pavements. Figure 20 illustrates the AASHTOWare Pavement ME Design main screen. Table 9 lists the main traffic data inputs for the M-E PDG and AASHTOWare along with the source location from the T-DSS (i.e., Table07\_M-E PDG and AASHTOWare Input Data). Data access is visual/manually with no possibilities of automated data export/import as these are federal developed/managed software.

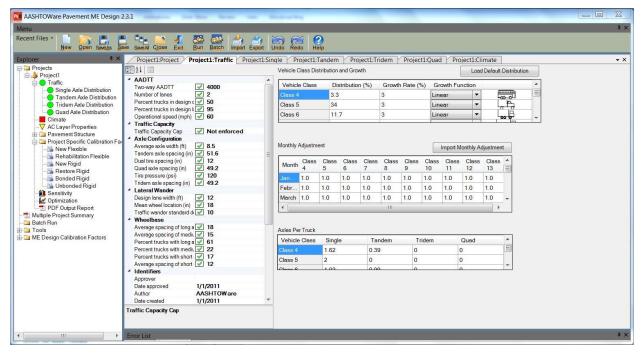


Figure 20 AASHTOWare Pavement ME Design Traffic Input Screen.

Item	Description (Location in the T-DSS = Table07a & 07b)	Comment
AADTT	Design Life (yrs.)	User
	Opening Date	Construction
	Initial two-way AADTT	
	Number of lanes in design direction	
	Percent of trucks in design direction (%)	
	Percent of trucks in design lane (%)	
	Operational Speed (mph)	
Axle Configuration	Average Axle width (ft.)	Default
	Dual tire spacing (inches)	Default
	Tire Pressure (psi)	Default
	Tandem/Tridem/Quad Axle spacing (inches)	Default
Lateral Wander	Mean wheel location (inches from the lane marking)	
	Traffic wander standard deviation (inches)	
	Design lane width (ft.) (Note: Not slab width)	
Wheelbase	Average Axle spacing of long/medium axles(ft.)	Default
	Percent of trucks with long/med/short axles (%)	
Traffic Volume Adjustment	Monthly adjustment	
Factors	Vehicle Class Distribution	
	Hourly Distribution	
	Traffic growth factors	
Axle Load Distribution Factors	Single/Tabdem/Tridem/Quad axle	
Number Axles/Truck	Single/Tandem/Tridem/Quad (Class 4 to 13)	

#### Table 9 List of Traffic Data Input for M-E PDG and AASHTOWare Pavement ME Design.

#### **EXPORTING TRAFFIC DATA**

Other traffic data contained in the T-DSS include traffic weights, overloading, and supplementary data such as the location of the WIM stations from Table08 to Table15. Accessing of the T-DSS data is typically achieved through the Microsoft Access function "External Data" that exports the data (selected table and/or data) into a tabular Excel format. This is exemplified in Figure 21 and Figure 22. The zipped attachments simply download by left-clicking on them just like any other standard download operation.

File Home Create External Data	Database 1	iools Fields Table 📿 Tell me what you want to do	
Saved Linked Table ports Manager Import & Link	Text File	Saved Excel Text File or XPS	
Custom	, 🛄 та Е	xport - Excel Spreadsheet	? ×
	P FPS	Select the destination for the data you want to export	
Table01_Traffic Volume, ESALs, & Vehicl	FPS FPS	Specify the destination file name and format.	
Table02_ADT, ADTT, & Vehicle Classificat	FPS FPS	Eile name: C:\Users\I-walubita\Documents\Table04_FPS Input DataxIsx	Browse
Table03_Traffic Volume Distribution (Dail	FPS FPS	File format: Excel Workbook (*.xlsx)	
Table04_FPS Input Data	FPS FPS FPS	Specify export options.	
Table05a_TxME Input Data (Level1 - Gen	FPS	✓ Export data with formatting and layout.	
Table05b_TxME Input Data(Level1-Class	FPS FPS	Select this option to preserve most formatting and layout information when exporting a table, query, form, or report.           Open the destingtion file after the export operation is complete.	
Table05c_TxME Input Data (Level2-Basic	FPS FPS	Select this option to view the results of the export operation. This option is available only when you export formatted data.	
Table06_TxACOL & TxCrackPro Input Data	FPS FPS	Export only the gelected records. Select this option to export only the selected records. This option is only available when you export formatted data and have records.	s selected.

Figure 21 The T-DSS Data Export (External Data  $\Rightarrow$  Excel).

District	County	HWY	LaneDirection	LaneDesignation	ADTbegin	ADTend-20Yr	.8-kips ESALs (mi	Avg Vehicle Speed (mph)	%Trucks in ADT	ATHWLD (kips)	ge Tandem Axles
Laredo	La Salle	IH 35	NB	Outside (L1)	6113	23001	39.08	65.00	47.00%	14.34	55.50%
Laredo	La Salle	IH 35	NB	Inside (L2)	2699	10155	5.49	65.00	13.00%	11.78	51.06%
Laredo	La Salle	IH 35	SB	Outside (L1)	6213	23377	40.11	65.00	51.00%	12.25	57.91%
Laredo	La Salle	IH 35	SB	Inside (L2)	2656	9994	5.76	65.00	14.00%	12.74	54.87%
Pharr	Hidalgo	US 281	NB	Inside (L2)	2124	6473	1.79	65.00	14.00%	13.03	46.84%
Pharr	Hidalgo	US 281	SB	Inside (L2)	2150	6552	1.69	65.00	17.00%	12.86	46.73%
Atlanta	Cass	FM 3129	SB	Outside (L1)	504	910	0.44	65.00	33.00%	12.8	60.12%
Bryan	Leon	SH 7	WB	Outside(L1)	1902	3435	5.31	67.10	20.50%	15.5	49.12%
Laredo	Dimmit	FM 468	EB	Outside(L1)	1977	3571	12.74	64.80	54.00%	15.5	57.78%
Corpus Christi	Live Oak	US 281	NB	Outside(L1)	1354	2445	37.31	33.70	77.00%	20.51	56.42%
Corpus Christi	Live Oak	US 281	SB	Outside(L2)	3801	6865	18.90	35.20	32.00%	15.29	56.15%
Brownwood	Comanche	SH 6	NB	Outside(L1)	2118	3825	2.25	69.00	22.40%	12.68	45.61%
Laredo	La Salle	IH 35	NB	Outside (L1)	6113	23001	39.08	65.00	47.00%	14.34	55.50%
Laredo	La Salle	IH 35	NB	Inside (L2)	2699	10155	5.49	65.00	13.00%	11.78	51.06%
Laredo	La Salle	IH 35	SB	Outside (L1)	6213	23377	40.11	65.00	51.00%	12.25	57.91%
Laredo	La Salle	IH 35	SB	Inside (L2)	2656	9994	5.76	65.00	14.00%	12.74	54.87%
Odessa	Midland	FM 1787	SB	Outside(L1)	2675	4831	8.85	65.40	33.80%	16.29	49.20%
Odessa	Midland	FM 1787	SB	Outside(L1)	2623	4737	7.99	64.70	30.20%	11.53	48.96%
Fort Worth	Wise	SH 114	EB	Outside (L1)	4802	23571	39.38	65.00	33.00%	16.97	44.70%
Fort Worth	Wise	SH 114	EB	Inside (L2)	3236	15884	8.80	65.00	16.00%	17.48	28.40%
Fort Worth	Wise	SH 114	WB	Outside (L1)	4378	21490	37.31	65.00	39.00%	11.56	36.90%
Fort Worth	Wise	SH 114	WB	Inside (L2)	2844	13960	6.87	65.00	15.00%	8.37	28.10%
Fort Worth	Wise	SH 114	EB	Outside (L1)	5800	10476	38.69	67.01	47.10%	12.53	54.12%
Brownwood	Comanche	SH 6	NB	Outside(L1)	1862	3362	3.76	68.34	22.10%	9.28	46.00%
Laredo	Dimmit	FM 468	EB	Outside(L1)	1380	2493	13.50	59.43	47.30%	11.14	61.30%
Amarillo	Potter	IH 40	EB	Outside (L1)	4774	11759	49.67	70.00	58.00%	16.57	55.91%
Amarillo	Potter	IH 40	EB	Inside (L2)	1140	2808	5.47	70.00	28.00%	14.27	45.57%
Amarillo	Potter	IH 40	WB	Outside (L1)	4722	11754	43.44	70.00	58.00%	17.12	54.86%
Amarillo	Potter	IH 40	WB	Inside (L2)	1340	3301	7.07	70.00	21.00%	14.35	46.75%

Figure 22 Example Data Export from The T-DSS (FPS Input Data).

# SECTION V. DATA ANALYSIS MACROS AND CLUSTERING ALGORITHMS

Three types of data analysis macros were developed to ensure consistent and efficient data analysis procedure. These macros are managed in the MS Excel VBA platform as MS Excel is able to support various computing methodologies required for the data analysis and is compatible with most computer machines. The three data analysis macros are:

- a) Portable WIM data analysis macro
- b) Permanent WIM data analysis macro
- c) Clustering analysis macro

### THE PORTABLE WIM DATA ANALYSIS MACRO

Once the raw data from the portable WIM unit is downloaded, it can be quickly parsed to several excel files each representing one-day data set. These daily raw data will usually still be in an unorganized state and doesn't represent any meaningful or interpretable data. The purpose of the portable WIM macro is to obtain the excel raw data and then, generate the M-E compatible traffic data for pavement design. Figure 23 shows the Portable WIM macro main screen.

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Generate the Daily Distribution     Page     Page	Create LEF & ESAL Page						
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Figure 23 Portable WIM Macro Main Screen

In order to operate the Portable WIM macro, the user can simply clicks on the "Quick Start" button, pick the destination folder where the result of the macro will be saved, then pick the raw data files that are going to be analyzed. It is recommended to have at least 7 days of data to ensure complete weekly data analysis. Additionally, the user can also generate specific desired outputs from one of the 12 buttons on the left side of the control panel. The macro running time ranges from 10 minutes to one hour depending on a highway's traffic volume and data quantity.

### THE PERMANENT WIM DATA ANALYSIS MACRO

The Permanent WIM data analysis macro has a similar purpose like the portable WIM macro but it is custom designed specifically for permanent WIM data analysis. Both Permanent WIM and portable WIM systems have two different formats of raw data, thus two separate macros were created for each system. Figure 24 shows the main screen for the permanent WIM Macro:

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Figure 24 Permanent WIM Main Screen

Due to the huge data size and different format of the permanent WIM station raw data, the permanent WIM station has slightly different methodology than portable WIM raw data. Users can click on the "Generate Monthly Analysis" button, pick the destination folder for monthly analysis, then select all of the raw data that needs to be analyzed. This will generate an analyzed version for each raw data selected, this type of files are the ones needed for the next three analysis outputs, namely: Volume Analysis, Weight Analysis, and Class Analysis. Each of the outputs can be generated from the "Generate Volume & Classification Data", "Generate ATHWLD Data", & "Generate Weight Distribution & Overloading data" buttons, respectively. The minimum macro running time is 8 hours and can go up to over 48 hours depending on the station data quantity.

# THE CLUSTER ANALYSIS MACRO

The purpose of the cluster analysis macro is to predict the most similar WIM stations based on the input given from the user. The program takes on four inputs as its indicator: Functional Class, AADTT, % Truck, & C5/C9 Ratio. Once the inputs are submitted, the macro will analyze the data and suggest the stations with the most similar attributes based on a scoring system. As of now, there are 36 stations in the clustering macro database, further addition of station data would improve the prediction analysis of the macro. Figure 25 shows the main screen of the Cluster macro:

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Figure 23 Cluster Macro Main Screen

The cluster macro outputs 5 of the most similar stations and presents each station's FPS Input, TxCrCRCP-ME Input, and TxME Input data. The user can then select his preference and then generate the required traffic data. Current running time is less than 10 minutes.