THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

PRODUCT 0-6817-P2
TxDOT PROJECT NUMBER 0-6817

Training Workshop Material

Research Supervisor:
C. Michael Walton

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CENTER FOR TRANSPORTATION RESEARCH

0-6817-P2

TRAINING WORKSHOP MATERIAL

Research Supervisor:
C. Michael Walton

TxDOT Project 0-6817: Review and Evaluation of Current Cross Vehicle Weights and Axle Load Limits

AUGUST 2016; PUBLISHED MARCH 2017

Performing Organization:	**Sponsoring Organization:**
Center for Transportation Research The University of Texas at Austin 1616 Guadalupe, Suite 4.202 Austin, Texas 78701	Texas Department of Transportation Research and Technology Implementation Office P.O. Box 5080 Austin, Texas 78763-5080
Performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.	

Table of Contents

Workshop Summary

On July 18, 2016, the research team held a workshop from 2:00 to 5:00 p.m. at the Center for Transportation Research (CTR). The main purposes of the workshop were to inform the attendees of

- the methodologies used to evaluate the pavement and bridge consumption of different truck configurations, and
- the cost recovery systems that can be used to fund the infrastructures maintenance, which is needed due to accelerated consumption of overweight vehicles.

Figure 1 provides the workshop agenda.

Project 0-6817 "Review and Evaluation of Current Gross Vehicle Weights and Axle Load Limits" Workshop

Date: Monday, July 18, 2016 – 2:00 PM to 5:00 PM

Location: Center for Transportation Research, Room 4.518
(1616 Guadalupe St., Suite 4.202, Austin, TX 78701)

Focus: Pavement and bridge consumption analysis methodology, cost recovery methods

AGENDA

2:00-2:15 PM	Purpose of the Workshop and Project Overview	Dr. Jorge Prozzi
2:15-2:45 PM	Framework for Pavement Consumption Calculation	Dr. Jorge Prozzi
2:45-3:15 PM	Framework for Bridge Consumption Calculation	Dr. Jose Weismann
3:15-3:45 PM	Cost Recovery Methods	Dr. Nan Jiang
3:45-4:30 PM	Discussion	Dr. Mike Murphy
4:30-4:50 PM	Workshop Effectiveness Survey	Dr. Nan Jiang
4:50-5:00 PM	Closing	Drs. Walton, Prozzi and Murphy

Figure 1. Workshop Agenda

In total, 20 people attended this workshop, including CTR researchers and representatives from the Texas Department of Transportation (TxDOT), the Texas Department of Motor Vehicles (TxDMV), and industry associations. In-person attendees included the following:

- Jorge Prozzi – CTR
- Jose Weissmann – University of Texas at San Antonio (UTSA)
- Angela Weissmann – UTSA
- Mike Murphy – CTR
- Nan Jiang – CTR
- Hui Wu – CTR
- Sarah Kouchaki – CTR
- John Wirth – TxDOT Maintenance Division, Pavement Preservation
- John Bilyeu – TxDOT Maintenance Division, Roadway Asset Management
- Mark McDaniel – TxDOT Maintenance Division, Roadway Asset Management
- Scott McKee – TxDMV Motor Carrier Division, Permits Section
- Kristy Schultz – TxDMV Motor Carrier Division
- Josh Winegarner - Texas Cattle Feeders Association

Attendees who joined the day's events via WebEx included:

- Chris Glancy – TxDOT's Research and Technology Implementation Division (RTI)
- Les Findeisen – Texas Trucking Association
- Gisel Carrasco – TxDOT
- Alejandro Miramontes – TxDOT
- DuWayne Murdock – TxDMV
- Rob Harrison – CTR
- Kevin Savage – CTR

Workshop presentations are attached as Appendix A.

Presentation 1: Framework for Pavement Consumption Calculation

Dr. Prozzi started the workshop with an introductory presentation on the project's background and scope, followed by an explanation of the methodology employed in this research to calculate the pavement consumption. He mentioned that the original method was developed in the "Rider 36" project in 2012. Project 0-6817 updated that method and evaluated more truck configurations. He also walked the attendees through a step-by-step explanation of the pavement consumption calculation using several examples of vehicles with different configurations and gross vehicle weights (GVWs). He showed that it is possible to have a configuration with low pavement consumption while carrying a load greater than 80 kips. Below is the summary of the major points and questions from the attendees regarding this part of the presentation:

- Currently, the AASHTO Road Test method called the "four-power law" is the method most commonly used to find the pavement consumption rate. According to this method, pavement damage is defined as the ratio of the weight of a given axle relative to the weight of a standard axle load to the power of four. This method implies that the load and its consumption are not linearly related. As the load increases, the consumption of the pavement and bridges grows much faster. However, instead of using a fixed standard axle

and power, the research team decided to find different standard axles and also powers based on axle types: single, tandem, tridem, and quad.

- The AASHTO test took place in the late 1950s; vehicle technologies have evolved considerably since then. Furthermore, the AASHTO method is based on one failure criterion, serviceability, which is associated with ride quality. The newly developed method is a mechanistic approach that has been calibrated with today's axle loads and vehicle configurations. This approach is based on three failure criteria: cracking, rutting, and roughness. Actual Texas pavements and environmental conditions were used to develop this method.

- The research team contacted representatives in the trucking industry and on the Transportation Research Board committee on truck weights and dimensions to gather information relating to the existing trucks configurations. We developed a database of 18 truck configurations based on the number, type, and spacing of axles.

- The primary goal of this project is to find the cost per mile for each vehicle. To that end, the research team selected a TxDOT-designed pavement, and determined how many equivalent single axle loads (ESALs) were required to cause a pavement to fail at the end of 20 years. Then, the research team determined how many passes of a given truck configuration would cause pavement failure at the end of 20 years. Using these findings, we determined the cost of a 1-mile overlay required to sufficiently reinforce the pavement. The same process was conducted for all configurations and pavements studied in this project. Note that only marginal cost was considered in this study.

- At the end of pavement consumption presentation, Scott McKee asked whether the width of the truck was considered a variable in the calculation. Dr. Prozzi answered that all truck configurations are based on the typical models. The research team didn't consider the width of trucks as a variable in the calculation, but used only axle loads, types, and spacing as the variables incorporated into the analysis.

Presentation 2: Framework for Bridge Consumption Calculation

Dr. Weissmann discussed the bridge consumption analysis. He explained that two databases were employed to gather the Texas bridge information. By matching two databases, the research team was able to extract the required information, including mileage, highway classification, urban/rural classification, and county. He indicated that the bridge mileage was important since this study was intended to determine the cost per mile of truck configurations. Below is the summary of the major points and questions from the attendees regarding this part of the presentation:

- Each bridge has an inventory rating and an operating rating. A bridge inventory rating is very similar to the bridge design life. In other words, if the bridge is submitted to the inventory rating, it will last for its design life. The inventory rating is the level of loading for a continuous goal. An operating rating is the level of loading that will stress the bridge for the one-time application.

- Just as with pavements, there is a power relationship based on a certain bridge structure's indicator to calculate the consumption ratio for each pass of a given truck. In this study, the consumption ratios were calculated using the bending moment of bridges. The research team developed a computerized model to calculate the moments and moment ratios of truck configurations and inventory ratings.

- The asset value of bridges were calculated by multiplying the bridge's deck area by $230 per square foot (the bridge replacement cost in Texas). According to the Federal Highway Cost Allocation study[1], heavy trucks are responsible for 11% of federal bridge costs.

- Mr. Robert Harrison noted that the bridge replacement cost in Texas is about $45/sq ft and asked why $230/sq ft was used in the analysis. Dr. Weissmann answered that $45 is a unit price that doesn't include the approach work required for replacing a bridge.

- At the end of the presentation, Dr. Weissmann provided two examples, illustrating the calculation of cost per mile of one truck in two different counties. He mentioned that the density of bridges in a county affects significantly the cost per mile of a given truck.

Presentation 3: Cost Recovery Methods

Dr. Jiang discussed the cost recovery methods and their applicability to oversize/overweight (OS/OW) vehicles. She first covered different cost recovery methods such as state fuel taxes, truck registration fees, truck sales tax, etc. Each of those methods presents its own potential issues. Below is the summary of the major points and questions from the attendees regarding this part of the presentation:

- Texas state fuel taxes and truck registration fees are lower than the national average. However, targeting these fees effectively to the OS/OW vehicles is difficult, as are truck sales tax and truck tire sales tax. Besides, increasing these taxes too much may induce the industry to buy trucks or truck tires from nearby states that have lower tax rates.

- Mr. Rob Harrison asked if the $840 registration fee Dr. Jiang mentioned in her presentation is for the trailer or for the tractor and trailer. Dr. Murphy responded by explaining that "There is a separate token trailer fee, which is $15. The $840 is for a tractor rated at 80,000 pounds GVW." The research team then asked for confirmation from Ms. Tammera Parr-Lamb from TxDMV; she confirmed that the TxDMV fee chart applies to a single unit truck, truck with trailer, or tractor with semi-trailer rated at the applicable GVW rate category. The registration fee for a truck registered as "combination" is based on the combined GVW of the truck and the trailer. Every trailer pulled by this combination-plated vehicle would be registered as a token trailer and pay the $15 fee.

- Mr. Josh Winegarner from the Texas Cattle Feeders Association commented that if Texas residents purchased trucks out of state, they still have to pay Texas tax. If they purchase the trucks out of state and they live out of state, then they pay tax for that other state. Mr.

[1] https://www.fhwa.dot.gov/policy/hcas/final/five.cfm

Harrison also mentioned that trucking companies that do long hauls and travel through several states have to keep log of their mileage and purchased fuels within those states.

- The OS/OW truck permit fee is the standard method to recoup costs associated with OW truck operations. A permit fee structure based on weight and distance is the most accurate one in terms of reflecting the damage of OS/OW vehicles to the infrastructure. However, this method requires installation of certain devices to weigh trucks and track truck mileages. Corridor-specific permit fees are also a good method to recover the cost caused by OS/OW vehicles to a specific corridor.

- As part of this project, the research team will develop guidelines for the implementation of the corridor-specific cost recovery system (see 0-6817-P3). These guidelines will use one corridor near the Port of Houston as an example to demonstrate:
  - The type of recovery methods that should be used.
  - The technologies that can help the cost recovery system, such as weighing systems, mileage tracking, etc.
  - Cost elements that need to be considered when developing the cost recovery fee collection systems. Some examples are pavement and bridge consumption cost, administration cost, the equipment maintenance cost, enforcement cost, etc.

Discussion

Dr. Murphy moderated a discussion in which the attendees provided their comments about the truck configurations.

- He mentioned that the research team could provide a better truck configuration analysis by including factors suggested by the industry.

- Mr. Josh Winegarner mentioned that some of the configurations analyzed by Dr. Prozzi apply to livestock trailers.

- Mr. Rob Harrison pointed out that trailer length is also a problem that needs to be considered, as they need to be maneuvered on the road and at the delivery places.

- Mr. Josh Winegarner mentioned that they would like to know how much additional weight a truck can carry if an additional axle is added. Dr. Murphy mentioned that there is no easy answer for that. Dr. Angela Weissmann added that this may be calculated for pavement, but not for bridges, especially if the whole truck fits in a bridge span—when excessive weight is placed on one span, the bridge may have serious failure. Pavement may get potholes in this situation, but it could be disaster for bridges. Mark McDaniel also agreed with this by saying that when it comes to bridges, what they need to consider is how many bridges they need to shut down.

- Mark McDaniel asked “Beyond pavement and bridge consumption, what are the other issues associated with a given configuration?” Dr. Weissmann said there other issues include factors such as geometry, safety, etc.

- At the end of the discussion, Dr. Murphy asked if anyone had any comments regarding the analysis and methodologies presented, any guidance they would like to give to Dr. Prozzi and Dr. Weissmann about additional factors to consider, or if they have individuals in mind that the group need to talk with to gain some additional insights about the industry. Mark McDaniel commented that there are many different permits and allowances. For instance, the agriculture industry has allowances for overweight loads, as do some other service trucks or concrete trucks. He wondered if there is some commonality that can be obtained from the analysis to effectively reduce the number of permit types. Dr. Murphy responded to Mark's comments by saying that "Dr. Prozzi presented the idea of expressing consumption in terms of consumption per pound of cargo. The dollars per VMT [vehicle miles traveled] is a very broad term that anyone can relate to money and one mile of travel, so it is a very good approach rather than just using the ESALs." Dr. Murphy also mentioned that the research team is open to other statistics or other methods to present this kind of information, and hoped for open dialogue between the research team and the industry. Dr. Prozzi added that from the infrastructure side, we are addressing the cost in terms of consumption. Therefore, we are commodity independent. However, from the benefit side, a pound of one commodity could have different impact in terms of the benefit to the state than might another commodity. However, that is out of our study scope.

- Finally, Dr. Murphy talked about the National Ready Mixed Concrete Association Fleet Survey. He mentioned that if other industries could benefit from such information-gathering efforts and the information can greatly benefit researchers as well.

Workshop Effectiveness Survey

The research team conducted a survey to evaluate the effectiveness of this workshop. The survey questions are attached as Appendix B. Four in-person attendees participated in this survey. Their responses are attached as Appendix C and summarized below.

- As to why they are interested in this workshop, TxDOT attendees noted that these analyses are related to their job. Industry representatives are interested in this project because they want to increase truck weight limits.
- Using a scale from 1, *not useful at all*, to 5, *extremely useful*, the attendees assessed each presentation as follows:
    - Presentation 1—Framework for Pavement Consumption Calculation: 4.3
    - Presentation 2—Framework for Bridge Consumption Calculation 4.7
    - Presentation 3—Cost Recovery Methods: 4.0
- The bridge cost analysis method and efficiency in Equivalent Consumption Factor per kips were regarded as particularly useful elements presented at this workshop.
- Attendees felt this workshop was quite thorough and had no suggestions for additional topics to cover.
- Regarding the possibility of attending similar workshops in the future, two attendees expressed that they were "very likely" to attend and two were "somewhat likely."

Appendix A: Workshop Presentation

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Project 0-6817
Review and Evaluation of Current Gross Vehicle Weights and Axle Load Limits

July 18th, 2016
2:00 – 5:00 PM

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TxDOT Project Manager

Sonya Badgley	RTI, TxDOT

PMC Members

Genevieve Bales	FHWA
Todd Copenhaver	TxDOT
Paul Reitz	Yoakum District , TxDOT
Wendy Simmons	Tyler District, TxDOT
John Wirth	TxDOT

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Research Team

Research Supervisor Dr. Mike Walton

Dr. Jorge Prozzi
Dr. Mike Murphy
Mr. Robert Harrison
Dr. Hui Wu
Dr. Nan Jiang
Kevin Savage
Sareh Kouchaki

UTSA
Dr. Jose Weissmann
Dr. Angela Weissmann

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Project and Workshop Objectives

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Project Objectives

- Review the methods to evaluate the effects of single, tandem, tridem, and quad-axle loads on Texas pavements and bridges.
- Evaluate infrastructure-friendlier vehicle configurations.
- Develop a cost-recovery structure that funds repairs to roads utilized by overweight trucks.
- Corridor feasibility.

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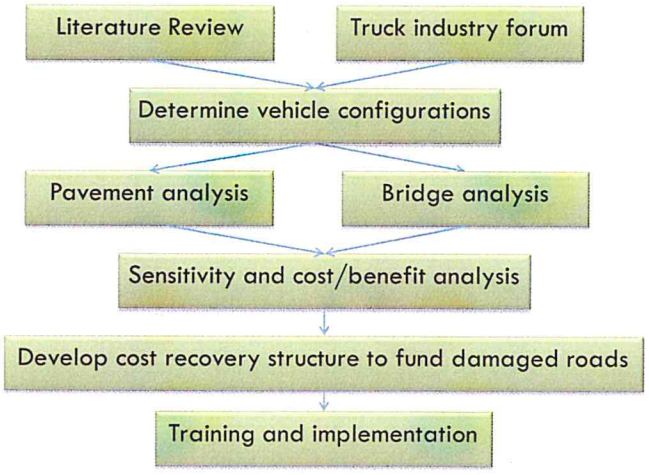
Project Plan



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Workshop Objectives

- To explain to a wider audience the basic methodologies for:
  - pavement consumption calculation
  - bridge consumption calculation
- Obtain feedback (pros, cons, limitations, room for improvements)
- Feedback on vehicle configurations

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Today's Agenda

- Introduction
- Pavement Analysis (Prozzi)
- Bridge Analysis (Weissmann)
- Cost Recovery (Jiang)
- Moderated Discussions (Murphy)
- Workshop Evaluation (Jiang)
- Closing

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Framework for Pavement Consumption Calculation

Dr. Jorge A. Prozzi
prozzi@mail.utexas.edu

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Mechanistic vs. Empirical

- Mechanistically-based method for the determining pavement consumption due to "OW Traffic" relative to "Design Traffic".
- Based on Rider 36 Study.
- Significant improvement over previous methodology:
  - Empirical and based on results of AASHTO Guide for Design of Pavement Structures.

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Mechanistic vs. Empirical

- From AASHTO's LEF (Load Equivalency Factor) to improved ECF (Equivalent Consumption Factor)
- $LEF = \left(\frac{Axle\ Load}{18{,}000}\right)^4$
- $ECF = \left(\frac{Axle\ Load}{18{,}000\ .\ n}\right)^k$

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Mechanistic vs. Empirical

- Load Equivalency Factor (LEF):
  - Empirical (based on AASHO Road Test)
  - 1950's vehicles and tires
- Equivalent Consumption Factor (ECF):
  - Mechanistically based
  - Nationally Calibrated (AASHTO and FHWA)
  - Multi-criteria for pavement performance
  - Today's vehicles
  - Actual Texas' pavements

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Mechanistic vs. Empirical

- Present Serviceability Index (PSI)
  - Slope Variance (+80%)
  - Cracking, Rutting and Patching (-20%)
- Vehicle Characteristics

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Analysis Framework

- **Step 1: Traffic Characterization**
  - We sampled 2,000 vehicles from OW Central Permitting System (CPS) database (now TxPROs)
  - We selected typical OW vehicles
  - Determined common axle configurations + axle loads

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Analysis Framework

- **Step 2: Determination of Routing and Pavement Structures**
  - Identify routes
  - Quantify vehicle miles travelled (VMT)
  - Select representative pavement structures
  - Develop pavement experimental design

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Analysis Framework

- **Step 3: Mechanistic-Empirical Pavement Analyses**
  - Axle configurations
    - Reference axle (18 kips single axle)
    - Single, tandem and tridem axles of different loads
  - Equivalent Consumption Factor (ECF) =
    - Number of 18,000 lbs single axles to fail a pavement /
    - Number of other axle to fail same pavement

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Analysis Framework

- **Step 3: Mechanistic-Empirical Pavement Analyses**
  - Muti-criteria analysis:
    - Rutting (deformation of pavement surface)
    - Cracking (formation of visible cracks)
    - Roughness (riding quality)

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Rutting

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Load-Associated Cracking

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Roughness

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Analysis Framework

- **Step 4: Determination of Consumption**
  - Determine the pavement performance under "Design Traffic"
  - Determine the "OW Traffic" that results in the same performance as the "Design Traffic"
  - Aggregate "Design + OW Traffic"
  - Determine the cost of pavement reinforcement to obtain equivalent performance as original design (**marginal cost only**)

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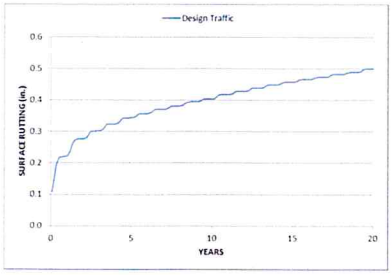
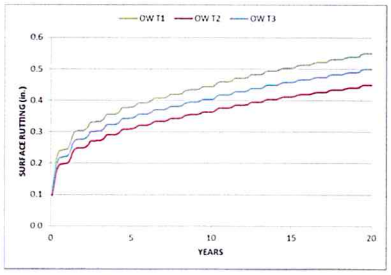
Analysis Framework

- **Step 4: Determination of Consumption**

Design Traffic

OW Traffic 1 = 300,000 vehicles
OW Traffic 2 = 200,000 vehicles
OW Traffic 3 = 240,000 vehicles





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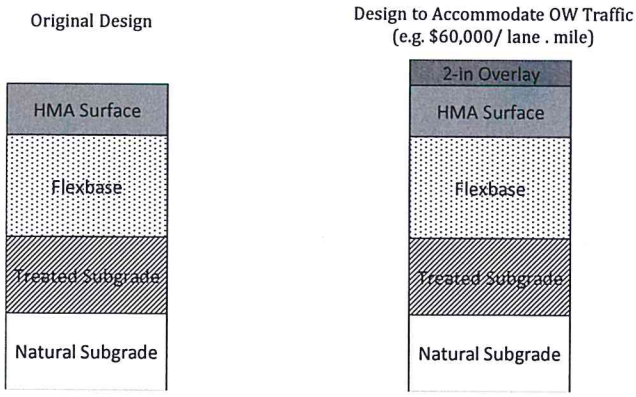
Analysis Framework

- **Step 4: Determination of Consumption**



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Analysis Framework

- **Step 5: Outcomes**
  - Step-by-step methodology to determine ECFs
  - ECFs for common vehicle configurations and pavement types for determining permit fees for specific vehicles and routes
  - Average ECFs for Texas for planning and programming purposes
- Based on marginal cost of reinforcing the new pavement.

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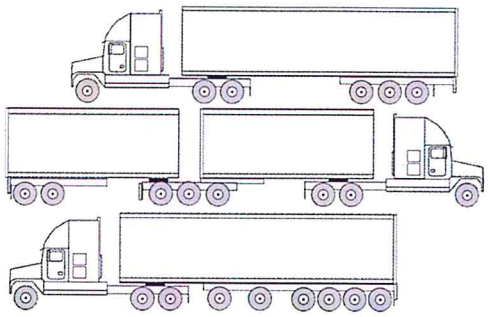
Examples of Pavement Consumption Calculation



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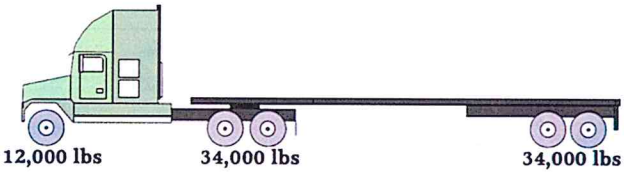
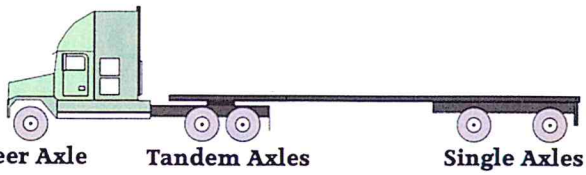
5-Axle Vehicles (80 to 90 kips)





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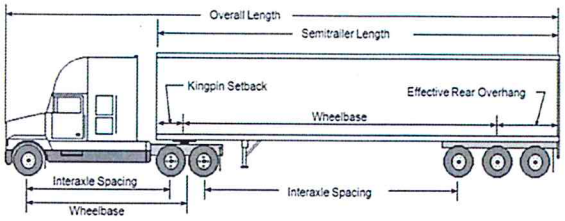
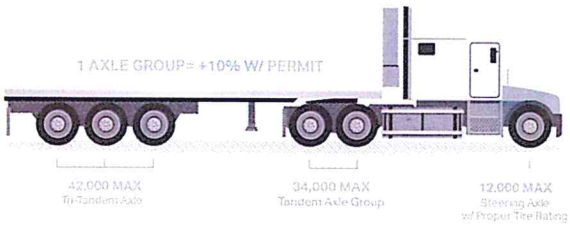
6-Axle Vehicles (80 to 102 kips)





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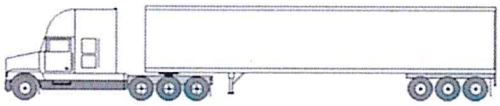
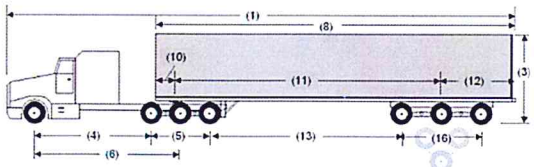
7-Axle Vehicles (80 to 112 kips)





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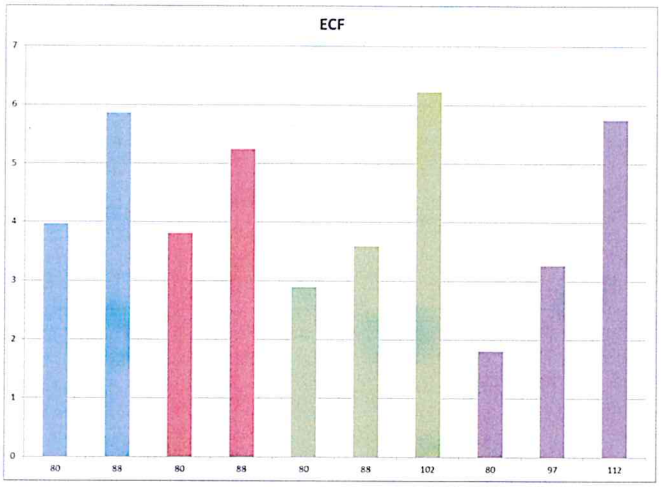
Consumption Comparison



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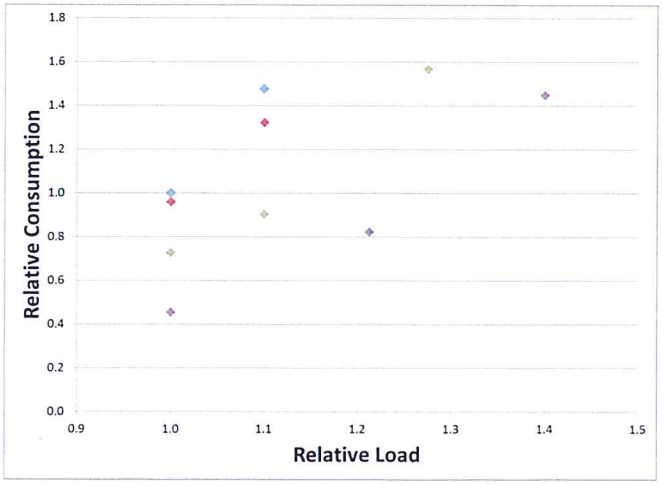
Efficiency Comparison



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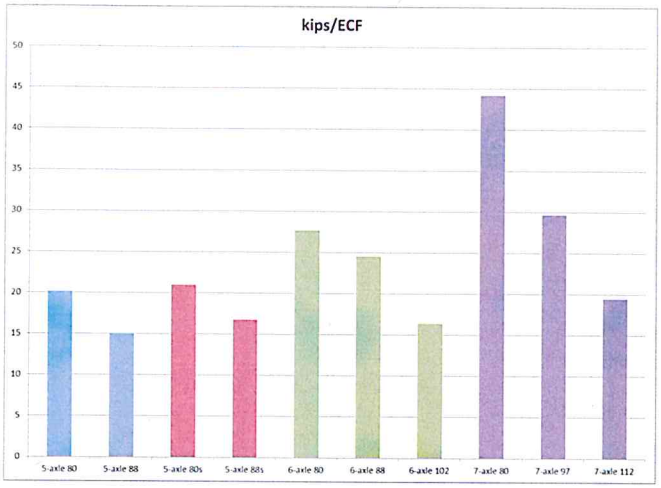
Efficiency in kips per ECF



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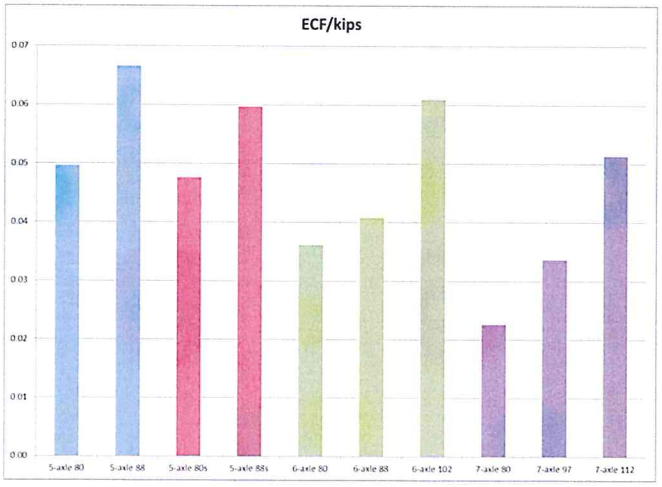
Efficiency in ECF per kips



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Preliminary Conclusions

- Strictly from a **pavement** perspective:
  - It is possible to carry 80 kips and produce less damage.
  - It is possible to increase GVM above 80 kips and produce the same damage as a 5-axle 80 kips.
- *"Pavements feel axles, bridges feel vehicles"*
- Bridge is an entire different analysis.

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Preliminary Conclusions

- The figures provided are just examples as the specific values depend on:
  - Pavement type
  - Pavement strength (e.g. SN)
  - Environmental conditions
  - Axle load distribution
  - Axle type and spacing
  - Tires per axle, tire type, inflation pressure
  - Etc., etc., etc.

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Thank you very much!

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Framework for Bridge Consumption Calculation

Dr. José Weissmann
Dr. Angela J. Weissmann

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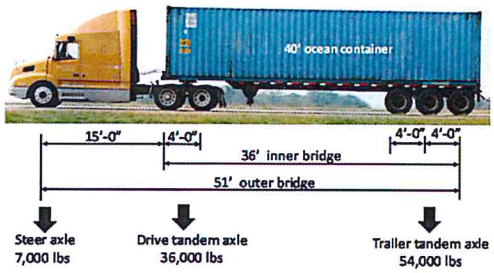

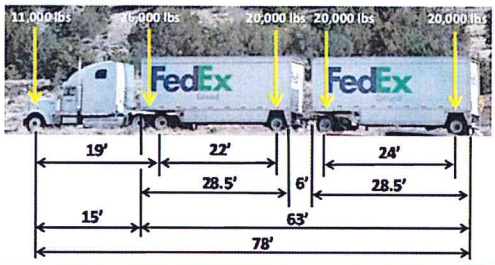

45 Configurations Evaluated
Containers, Ready Mix, Milk etc

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Data Sources

Federally mandated bridge inventory **BRINSAP/NBI**	TxDOT's Roadway Highway Inventory Network **RHINO**
Bridge data Highway classification Urban/rural County	Roadway segment mileage Highway classification Urban/rural County

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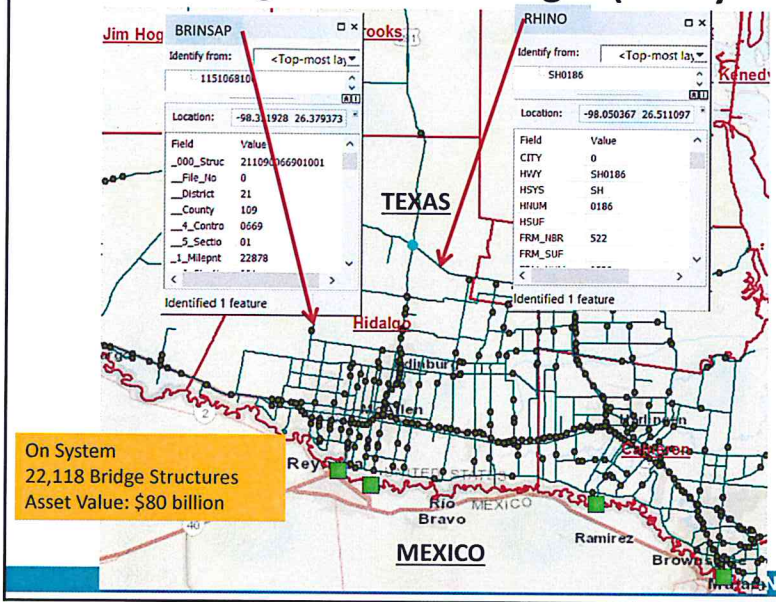
Road Segments and Bridges (GIS System)



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Data Preparation

1. Assign a consistent urban/rural classification for bridges BRINSAP/NBI (some inconsistencies resolved manually)
2. Harmonize highway classifications (RHINO and BRINSAP) Example: BRINSAP uses value 15 for both FM and RM. RHINO separates FM and RM
3. **Result:** Assign the same highway classification to bridges and RHINO segments

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Calculations

1. RHINO: total **alignment** mileage in each county, urban/rural area, and highway classification
2. BRINSAP: number of bridges in each county, urban/rural area, and highway classification
3. Handle parallel bridges. Rhino provides only alignment center line miles

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Structural Analysis

- **Objective:** bridge consumption costs per mile, in each highway class, by urban/rural area and by county.
- Concepts: ratings, moments, fatigue
- Formulas
- Results

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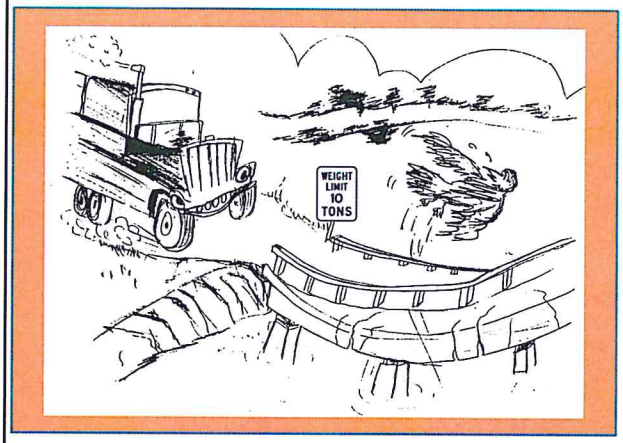
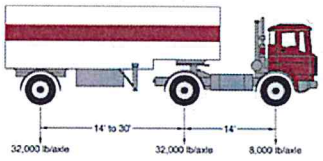
Each Bridge has a Rated Capacity Recorded in the Database (HS Loading)



Inventory Rating
Operating Rating



HS20 TRUCK

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Bridge Fatigue Concepts

General Formulation of Fatigue

Log N = C – m Log S

$$ConsumptionRatio = \left(\frac{M_{OSOW}}{M_{Inventory}}\right)^{m} = \frac{N_{Inventory}}{N_{OSOW}} = \frac{S^{m}_{OSOW}}{S^{m}_{Inventory}}$$

- $M_{inventory}$, M_{OSOW}—Live load moments for the Inventory Rating load and OSOW configuration respectively (surrogate for the stress range)
- Consumption Ratio — Consumption factor for the OSOW load relative to the Inventory Rating load for one passage of the OSOW load
- m — Constant dependent on material and bridge detail
- N — Number of allowable cycles to failure
- S — Stress range

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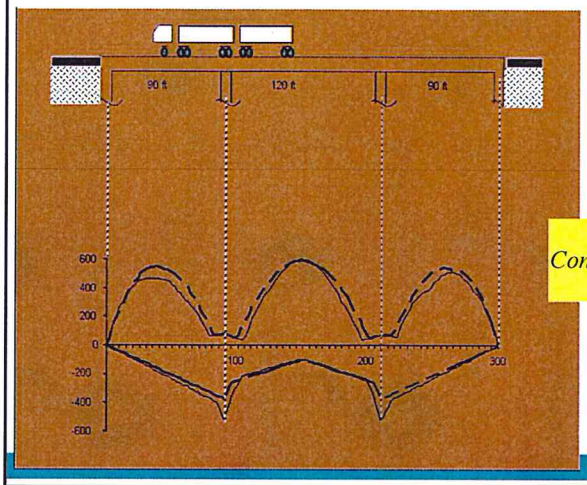
Computerized Bending Moment Envelopes

Calculation of $M_{inventory}$ and M_{OSOW} for network of thousands of bridges
Uses BRINSAP/NBI data



$$ConsumptionRatio = \left(\frac{M_{OSOW}}{M_{Inventory}} \right)^{m}$$

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Bridge Consumption – Asset Value

- Asset Value = Deck Area x 230 $/sqft
- How much of the Asset Value is Heavy Truck responsibility ?
- Federal Highway Cost Allocation Study

Vehicle Class	Percent Allocation
Passenger Vehicles	65.02%
Trucks	
Single Unit	7.67%
Combinations	
under 50 kips	2.68%
50 - 70 kips	5.15%
70 - 75 kips	8.41%
Over HS20-44 Loading	11.08%
TOTAL =	100.00%

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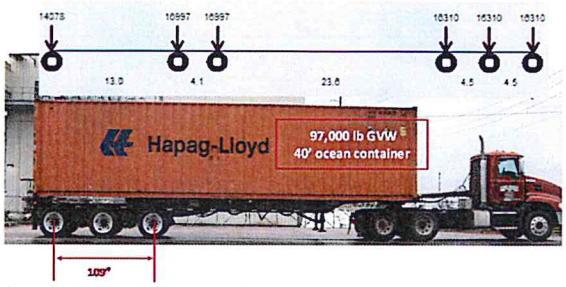
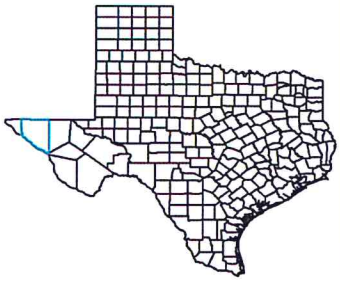
Detailed Results for One Container Configuration
Hudspeth County





County	UR	Functional Class	#Bridges	Cost	Miles	Density	$/mile
HUDSPETH	RURAL	FM/RM/PR	8	2.69	134.4	0.060	0.020
HUDSPETH	RURAL	IH	24	3.15	73.1	0.328	0.043
HUDSPETH	RURAL	SH	2	1.01	16.7	0.120	0.061
HUDSPETH	RURAL	SL/SS/BR/OSA	2	1.24	4.1	0.484	0.299
HUDSPETH	RURAL	US	3	1.43	65.3	0.046	0.022
Totals			**39**	**9.51**	**293.7**	**0.133**	**0.032**

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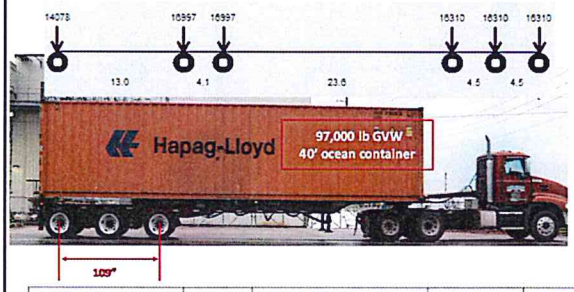
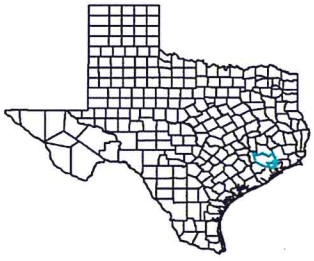
Detailed Results for One Container Configuration
Harris County





County	UR	Functional Class	#Bridges	Cost	Miles	Density	$/mile
HARRIS	RURAL	US	18	8.10	18.3	0.986	0.443
HARRIS	URBAN	FM/RM/PR	36	21.28	124.7	0.289	0.171
HARRIS	URBAN	IH	432	347.74	166.8	2.590	2.085
HARRIS	URBAN	SH	185	147.78	122.9	1.505	1.202
HARRIS	URBAN	SL/SS/BR/OSA	242	253.96	130.4	1.856	1.948
HARRIS	URBAN	US	249	222.98	71.0	3.509	3.142
Totals			**1162**	**1001.82**	**634.0**	**1.833**	**1.580**

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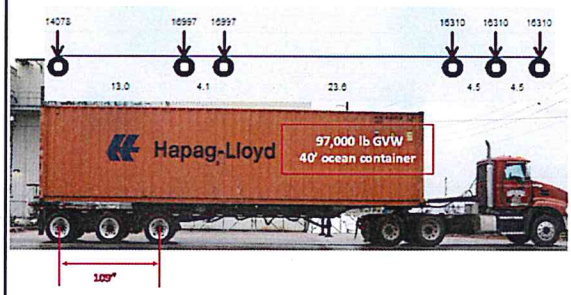
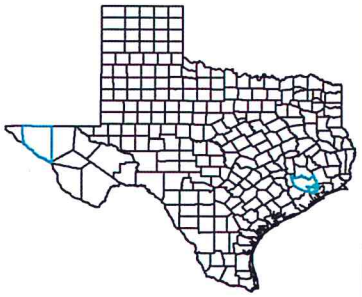
Detailed Results for One Container Configuration Harris vs Hudspeth County





Harris County	#Bridges	Cost	Miles	Density	$/mile
Totals	1162	1001.82	634.0	1.833	1.580

Hudspeth County	#Bridges	Cost	Miles	Density	$/mile
Totals	39	9.51	293.7	0.133	0.032

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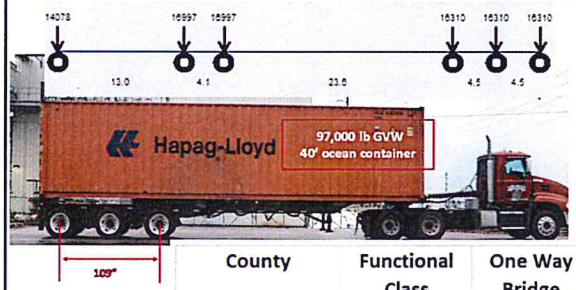
Bridges Expected to be Above Operating Rating Harris County



County	Functional Class	One Way Bridge Count	Percent Above Operating Rating	One Way Bridges Above Operating Rating
HARRIS	FM/RM/PR	36	0	0
HARRIS	IH	432	3.5	15
HARRIS	SH	185	0.5	1
HARRIS	SL/SS/BR/OSA	242	1.2	3
HARRIS	US	267	2.2	6
Totals		1162	2.2%	25

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Summary
And Yes the Presentation is almost Over

- Developed computerized methodology to calculate bridge consumption per mile using county mileage per functional class and bridge fatigue concepts.

- Calculated tables for bridge consumption per mile, summarizing the results for a library of 45 vehicles configurations: Container Chassis, Milk Trucks, Ready Mix Trucks.

- Results are summarized by county, functional class, urban or rural. Percentages of bridges probably exceeding operating rating are also summarized.

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Cost Recovery

Dr. Nan Jiang
Kevin Savage

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- State Fuel Taxes
- Truck Registration Fees
- Truck Sales Tax
- Truck Tire Sales Tax
- OW Truck Permit Fees
- Weight-miles fees
- Corridor-specific Truck Fees

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State Fuel Taxes

- Texas state tax is 20 cents/gallon for both gasoline and diesel.
- Federal tax is 18.4 cents/gallon for gasoline and 24.4 cents/gallon for diesel.
- Only 7 states have cheaper diesel fuel tax than TX. PA most expensive at 65.1 cents/gallon of diesel.

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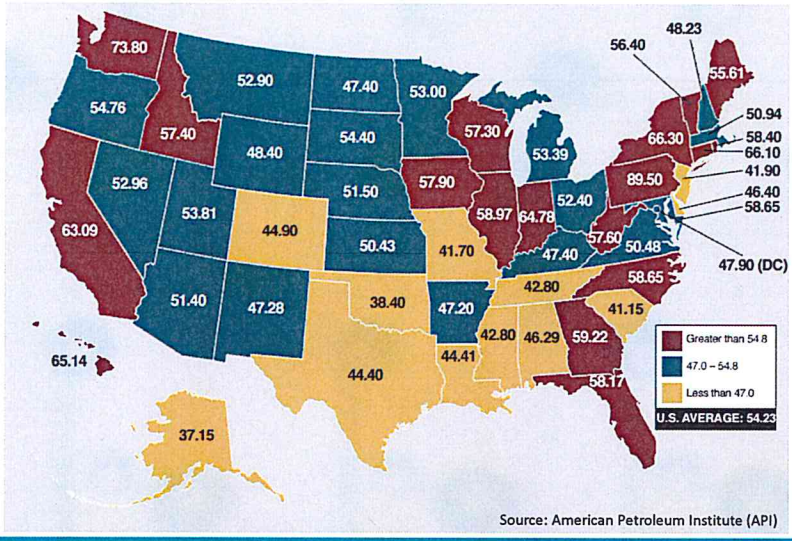
Total Federal and State Diesel Fuel Tax Rates



Source: American Petroleum Institute (API)

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State Fuel Taxes

- Increase in state fuel tax would impact OW trucks due to increased fuel consumption (versus trucks operating at weight limit).
- However, other factors contribute to amount of fuel consumed including fuel efficiency of truck and average speed.

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Truck Registration Fees

- All trucks required to pay registration fees.
- Vehicles pay registration fee for weight up to 80,000 lbs. Vehicles plan to carry more need to purchase OW permit.
- Texas registration fee significantly less than many other states and national average (see figure on next slide).
- Increase in registration fee may lead to trucks relocating to nearby states with cheaper fees.

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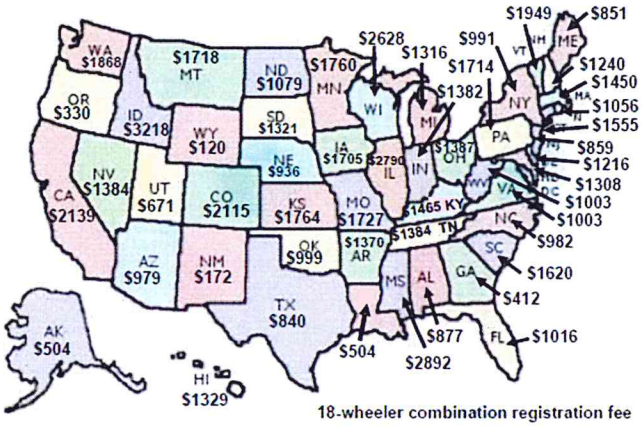
5-Axle Truck Registration Fees (as of January 2008)



18-wheeler combination registration fee

National Average: $1,338

Source: Texas 2030 Committee

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Truck Sales Tax

- Texas levies state sales tax of 6.25% on truck sales; federal tax of 12% on trucks over 33,000 GVW and trailers over 26,000 lbs (loaded).
- Difficult to target which trucks will carry OW loads at point of sale.
- Trucks may be purchased out-of-state or out-of-country and operate OW loads in TX.
  - New Mexico - zero
  - Arkansas - 6.5%
  - Oklahoma - zero
  - Colorado - 2.9%
  - Louisiana - 4%

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Truck Tire Sales Tax

- Federal tire tax rate is 9.45 cents for every 10 lbs of max rated load capacity over 3,500 lbs.
- Several states employ recycling or environmental fee on tire sales (only a few $).
- OW trucks may need additional tires or may replace tires more often than trucks operating at legal limit; however, not a straightforward relationship.
- Truckers could purchase tires in a nearby state if tax is too high.

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OW Truck Permit Fees

- Standard method to recoup costs associated with OW truck operations.
- Texas fee based on weight group:
  - GVW < 120,000: $210
  - GVW 120,000-160,000: $285
  - GVW 160,000-200,000: $360
  - GVW > 200,000: $435 + vehicle supervision fee

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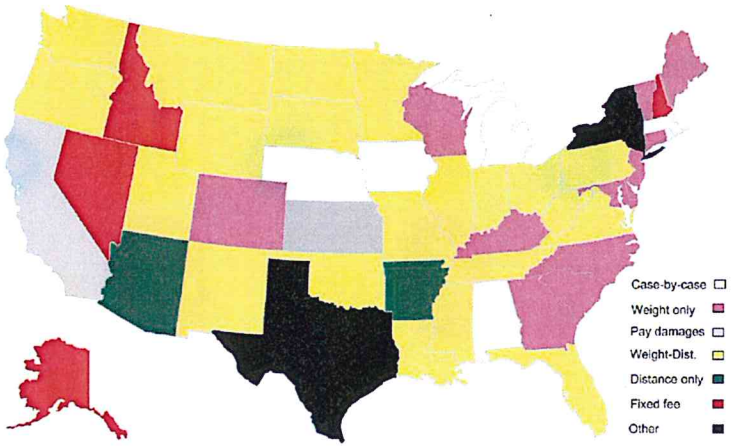
OW Single-Trip Permit Fee Structures



Source: NCHRP

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OW Truck Permit Fees

- Rider 36 Study: Only 20-25% of total OW truck operations costs are collected through permit fees; numerous exempt OW trucks.
- Many states (yellow on previous map) have introduced weight-distance based fee due to increased highway consumption as distance increases.

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Weight-Distance Fees

- Fee based on OW vehicle weight and distance traveled.
- Cost recovery method most similar to actual costs incurred.
- Devices required to weight vehicles and track mileage.

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Mileage Tracking Methods

- Simple methods such as self-reporting and hubometers - subject to tedious recordkeeping and potential inconsistencies.
- Entry/exit barriers – infrastructure required.
- New innovative technologies such as electronic mileage tracking (next slide) and geofencing.

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DITCH THE HUBO!

EROAD's electronic distance recorder for trucks (Ehubo) and trailers (Tubo) are the key to unleashing the comprehensive benefits available from EROAD's advanced technology platform.

Vehicle downtime for unnecessary hubodometer replacements are a significant business interruption. Hubodometers have annual failure rates upwards of 100% because they are rigidly mounted on an axle with the tyre being the only protection from road shocks. Hubodometers can increase distance recorded by upwards of 7% from tyre wear and in excess of 10% from faulty operation.

The Ehubo and Tubo are approved as a replacement for mechanical hubodometers, and overcome all the shortcomings associated with mechanicals. Their electronic display also means that paper RUC labels are no longer needed.

Source: www.eroad.com

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Corridor-Specific Fees

- Examples in Texas: Hidalgo County Regional Mobility Authority, Port of Brownsville and Port of Freeport.
- Single permit fee for vehicle operating on the corridor; used for administration of permitting system and maintenance of infrastructure.
- Direct correlation between operation of OW vehicle and cost recovery through permit fees.

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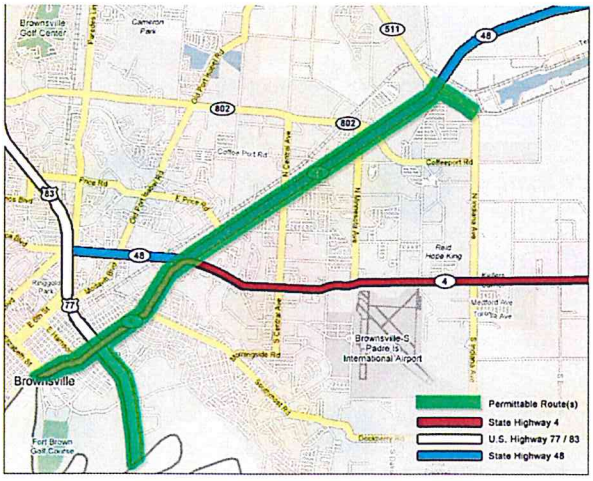
Port of Brownsville OW Corridor



Source: Texas Promiles

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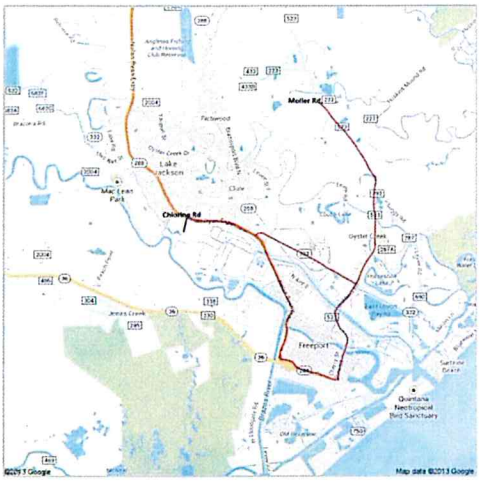
Port of Freeport OW Corridor



Source: Texas Promiles

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Corridor-Specific Fees

- Corridors often begin at port or border entry and end at specific industrial facilities.
- Area could be geofenced and linked to scales or weigh stations at port or border crossing, allowing fee collection by weight or weight-distance.

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0-6817 Corridor-Specific Approach

- This project seeks to develop guidelines for implementation of corridor cost recovery system.
- Two corridors near the Port of Houston chosen for further study; both include several petrochemical plants.

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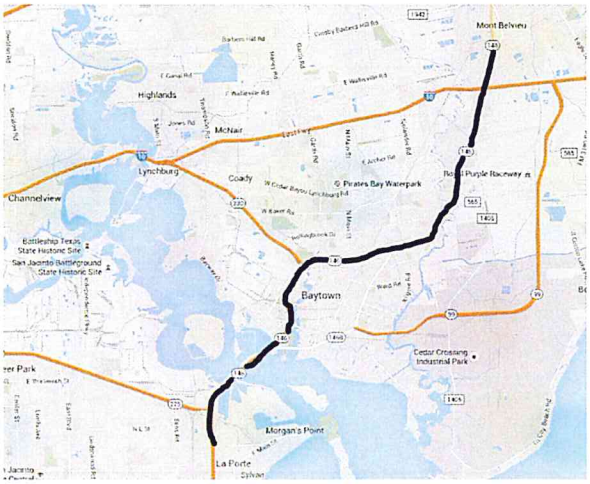
SH 146 Corridor



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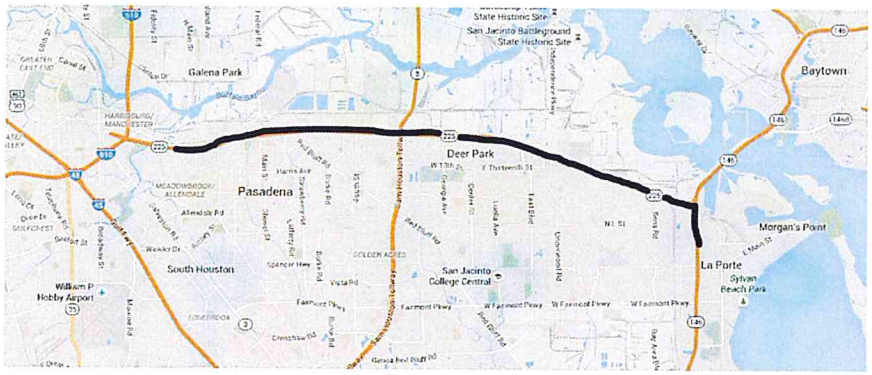
SH 225 Corridor



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Corridor-Specific Approach

- What will be discussed in detail in this project:
  - What recovery methods (single trip permit, annual permit, toll tag, etc.) should be used?
  - What technology (if any) should be implemented to aid in cost recovery/permit fee collection?
  - What OW costs to include in cost recovery?

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Discussion

Dr. Mike Murphy

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Workshop Evaluation Survey

Dr. Nan Jiang

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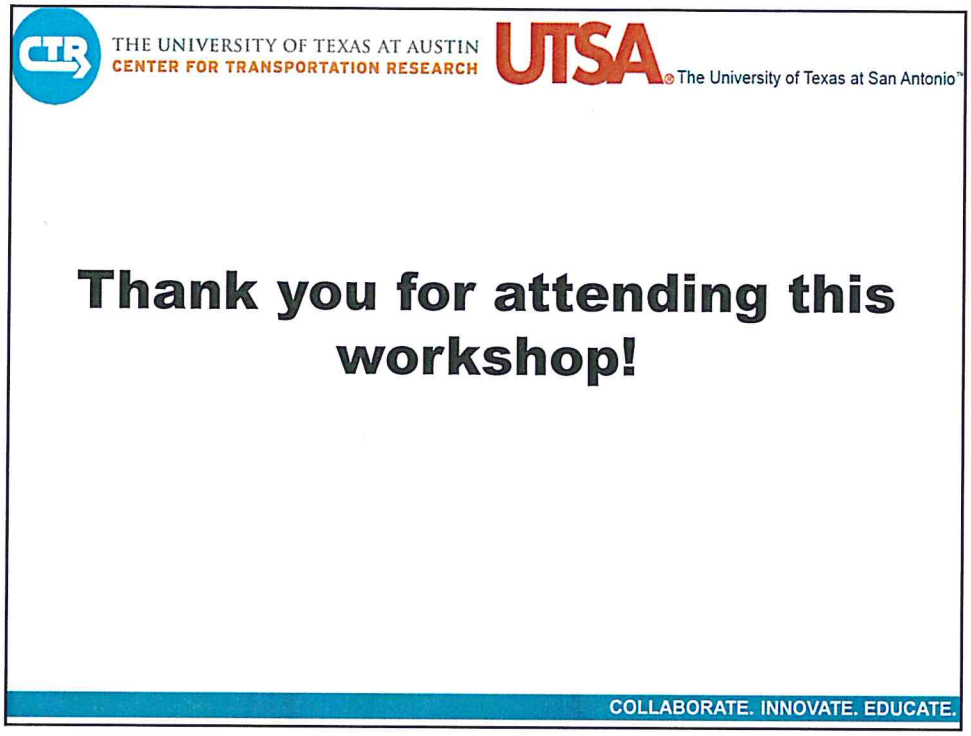
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The University of Texas at San Antonio
Thank you for attending this workshop!
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Appendix B: Workshop Evaluation Survey

0-6817 Workshop Evaluation Survey

Thank you for taking the time to participate in the workshop. We would appreciate if you could take a few minutes to share your opinions regarding the effectiveness of this workshop with us.

Please return this form to workshop organizers at the end of the workshop. Thank you.

---

1. Why are you interested in this workshop?

2. From scale 1 (not useful at all) to 5 (extremely useful), how useful do you think each presentation is?

Presentation 1: Framework for Pavement Consumption Calculation	1	2	3	4	5
Presentation 2: Framework for Bridge Consumption Calculation	1	2	3	4	5
Presentation 3: Cost Recovery Methods	1	2	3	4	5

3. What information presented at this workshop is particularly useful to you?

4. **What information do you think should have been presented but was not covered in this workshop?**

5. **How likely would you attend other oversize/overweight vehicle or other similar workshops hosted by CTR in the future?**

- ☐ Extremely likely
- ☐ Very likely
- ☐ Somewhat likely
- ☐ Not so likely
- ☐ Unlikely

6. **Additional information you would like to share. Please provide your name, e-mail, and phone number if you would like us to contact you for follow-up discussions.**

Thank you very much for taking time to complete the survey!

Appendix C: Workshop Evaluation Survey Responses

0-6817 Workshop Evaluation Survey

Thank you for taking the time to participate in the workshop. We would appreciate if you could take a few minutes to share your opinions regarding the effectiveness of this workshop with us.

Please return this form to workshop organizers at the end of the workshop. Thank you.

1. Why are you interested in this workshop?

TO INCREASE TX TRUCK WEIGHT LIMITS

2. From scale 1 (not useful at all) to 5 (extremely useful), how useful do you think each presentation is?

Presentation 1: Framework for Pavement Consumption Calculation	1	2	3	(4)	5
Presentation 2: Framework for Bridge Consumption Calculation	1	2	3	(4)	5
Presentation 3: Cost Recovery Methods	1	2	3	(4)	5

3. What information presented at this workshop is particularly useful to you?

EFFICIENCY IN ~~KIPS PER~~ ELF PER KIPS

4. **What information do you think should have been presented but was not covered in this workshop?**

5. **How likely would you attend other oversize/overweight vehicle or other similar workshops hosted by CTR in the future?**

- ☐ Extremely likely
- ☒ Very likely
- ☐ Somewhat likely
- ☐ Not so likely
- ☐ Unlikely

6. **Additional information you would like to share. Please provide your name, e-mail, and phone number if you would like us to contact you for follow-up discussions.**

Thank you very much for taking time to complete the survey!

0-6817 Workshop Evaluation Survey

Thank you for taking the time to participate in the workshop. We would appreciate if you could take a few minutes to share your opinions regarding the effectiveness of this workshop with us.

Please return this form to workshop organizers at the end of the workshop. Thank you.

1. Why are you interested in this workshop?

Assigned to Research team

2. From scale 1 (not useful at all) to 5 (extremely useful), how useful do you think each presentation is?

Presentation 1: Framework for Pavement Consumption Calculation	1	2	3	4	(5)
Presentation 2: Framework for Bridge Consumption Calculation	1	2	3	4	(5)
Presentation 3: Cost Recovery Methods	1	2	3	4	(5)

3. What information presented at this workshop is particularly useful to you?

ACC

4. **What information do you think should have been presented but was not covered in this workshop?**

?

5. **How likely would you attend other oversize/overweight vehicle or other similar workshops hosted by CTR in the future?**

- [x] Extremely likely
- [ ] Very likely
- [ ] Somewhat likely
- [ ] Not so likely
- [ ] Unlikely

6. **Additional information you would like to share. Please provide your name, e-mail, and phone number if you would like us to contact you for follow-up discussions.**

Thank you very much for taking time to complete the survey!

0-6817 Workshop Evaluation Survey

Thank you for taking the time to participate in the workshop. We would appreciate if you could take a few minutes to share your opinions regarding the effectiveness of this workshop with us.

Please return this form to workshop organizers at the end of the workshop. Thank you.

1. Why are you interested in this workshop?

It is part of my job to do Bill-specific cost analyses & Port corridor analyses.

2. From scale 1 (not useful at all) to 5 (extremely useful), how useful do you think each presentation is?

Presentation 1: Framework for Pavement Consumption Calculation	1	2	3	(4)	5
Presentation 2: Framework for Bridge Consumption Calculation	1	2	3	4	(5)
Presentation 3: Cost Recovery Methods	1	2	3	(4)	5

3. What information presented at this workshop is particularly useful to you?

Bridge cost analysis method

4. **What information do you think should have been presented but was not covered in this workshop?**

Nothing - very thorough

5. **How likely would you attend other oversize/overweight vehicle or other similar workshops hosted by CTR in the future?**

- ☐ Extremely likely
- ☐ Very likely
- ☑ Somewhat likely
- ☐ Not so likely
- ☐ Unlikely

6. **Additional information you would like to share. Please provide your name, e-mail, and phone number if you would like us to contact you for follow-up discussions.**

Thank you very much for taking time to complete the survey!

0-6817 Workshop Evaluation Survey

Thank you for taking the time to participate in the workshop. We would appreciate if you could take a few minutes to share your opinions regarding the effectiveness of this workshop with us.

Please return this form to workshop organizers at the end of the workshop. Thank you.

1. Why are you interested in this workshop?

Invited a consumption analyses performed.

2. From scale 1 (not useful at all) to 5 (extremely useful), how useful do you think each presentation is?

Presentation 1: Framework for Pavement Consumption Calculation	1	2	3	4	5
Presentation 2: Framework for Bridge Consumption Calculation	1	2	3	4	5
Presentation 3: Cost Recovery Methods	1	2	(3)	4	5

3. What information presented at this workshop is particularly useful to you?

N/A

4. **What information do you think should have been presented but was not covered in this workshop?**

NA -

5. **How likely would you attend other oversize/overweight vehicle or other similar workshops hosted by CTR in the future?**

- ☐ Extremely likely
- ☐ Very likely
- ☒ Somewhat likely
- ☐ Not so likely
- ☐ Unlikely

6. **Additional information you would like to share. Please provide your name, e-mail, and phone number if you would like us to contact you for follow-up discussions.**

McDaniel – Late to presentations so ratings are difficult

Thank you very much for taking time to complete the survey!