THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

PRODUCT 0-6817-P1
TxDOT PROJECT NUMBER 0-6817

Truck Industry Forum Material

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Michael Murphy
C. Michael Walton
Jorge A. Prozzi

March 2015; Published March 2017

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TRUCK INDUSTRY FORUM MATERIAL

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

MARCH 2015; 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.	

The following PowerPoint presentation is the draft version of the presentation that will be used for the upcoming half-day Infrastructure-Friendlier Trucks Forum tentatively scheduled for Friday, March 13, 2015. This forum will present a project status update, a presentation by Mr. John Woodrooffe (University of Michigan Transportation Research Institute) on the state of the freight industry with respect to the size and weight issue, a review and evaluation of current gross vehicle weights and axle load limits, and a discussion session to attain input from the industry on limitations for non-conventional vehicle configurations as well as potential benefits and costs that may come from changes in the truck size and weight regulations. The invitees for the forum will include research team members from the Center for Transportation Research (CTR) and the University of Texas at San Antonio (UTSA), industry experts, representatives from truck manufacturers and operators, and individuals from the Texas Department of Transportation and the Federal Highway Administration.

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Infrastructure-Friendlier Trucks Forum and 0-6817 Project Update

March 13, 2015

0-6817 Project Overview

- Project Reviews and Extends Previous Project Work:
  - Project 0-6736
  - Rider 36 OS/OW Vehicles Permit Fee Structure
- Focus on State, Federal, and International Efforts for the Evaluation of:
  - Single, Tandem, Tridem, and Quad-axle Configurations
  - Bridges and Pavements
- Develop Guidelines for More Infrastructure-Friendly Vehicle Configurations
- Develop Cost Recovery Structure to Fund Repairs to Roads Utilized by Overweight Trucks
  - Methodology Compatible with Proposed Determination of Fees with Oversize/Overweight (OS/OW) Vehicles.

PROJECT STATUS UPDATE

0-6817 Tasks

- Task 1 – Review of Existing Work
  - Similar Work in Texas, the US, and Internationally
- Task 2 – Develop Project Advisory Panel
  - Phone Interviews & Infrastructure-Friendlier Trucks Forum
- Task 3 - Vehicle Configurations to Be Tested
  - 12 Identified Existing and Non-Conventional Alternative Vehicle Configurations
- Task 4 – Pavement Analysis
  - Methodology for the Determination of Equivalent Consumption Factors (EFCs)
- Task 5 – Bridge Analysis
- Task 6 – Comparative Analysis
  - Sensitivity Analysis
- Task 7 – Generalized Benefits/Cost Analysis

- Task 8 - Cost Recovery Structure Development
  - Fund Repairs to Roads Utilized by OW Vehicles
- Task 9 – Workshop
  - Inform and Train Truck Manufacturers and Operators on Study Findings
- Task 10 – Case Study Development

Task 1 – Review of Existing Work

- Previous Work Under 0-6736
  - Add details of effort here
- Efforts in Texas
  - Add details here

Task 1 – Review of Existing Work

- Efforts in US
  - Add details here
- Efforts Internationally
  - Add details here

Task 1 – Review of Existing Work

- Deliverables
  - Technical Memorandum/Literature Review, Delivery Date
  - PowerPoint of Task 1 Summary Results, Delivery Date
  - PMC Presentation, Date

Task 2 – Develop Project Advisory Panel

- Advisory Panel Members:
  - John Woodrooffe, Industry Expert
  - John Billings, Consultant on TS&W and Canadian Truck Technology
  - Tom Kearney, FHWA
  - John Esparza (?), Texas Trucking Association
  - Frito Lay Representative
  - HEB Representative
  - Skip Yeakel, Volvo
- Infrastructure-Friendlier Trucks Forum

Task 2 – Develop Project Advisory Panel

- Deliverables
  - Product 1 Presentation Materials, Delivery Date
  - Attendance Sheet, To be Submitted Tomorrow
  - Activity Log of Identified Manufacturers & Operators Interviewed, Delivery Date
  - PMC Presentation of Results, Delivery Date

Task 3 – Vehicle Configurations to be Tested

- Identified Existing and Non-Conventional Alternative Vehicle Configurations
  - Add Details of Configurations
- Bridge Structures Identified
  - Add Details Here

Task 3 – Vehicle Configurations to be Tested

- Results Here
- Deliverables
  - Tech Memo, Delivery Date

Task 4 – Pavement Analysis

- Define Methodology for the Determination of Equivalent Consumption Factors (EFCs)
- Pavement Analysis for Configurations Identified in Task 3 Results
- Deliverables
  - Tech Memo, Delivery Date

Task 5 – Bridge Analysis

- Detailed Bridge Analysis for Configurations Identified in Task 3
- Summary of Costs for Potential Structural Upgrades for Deficient Bridges
- Georeferenced Database
- Network Level Bridge Analysis
- Deliverables
  - Tech Memo, Delivery Date

Task 6 – Comparative Analysis

- Sensitivity Analysis on Task 4 & 5 Assumptions
  - Compare Consumptions & Efficiencies of Vehicle Configurations Used in Texas to Alternative Configurations from Task 3
- Deliverables
  - Tech Memo, Delivery Date

Task 7 Generalized Benefits/Cost Analysis

- Identify and Quantify Important Benefits and Costs of Operating More Infrastructure-Friendly Trucks (IFTs)
- Conduct a Generalized Benefit Cost Analysis (BCA) on IFTs
  - Consumption of Pavement, Bridges, & Fuel
  - Acquisition/Upgrading of Truck Fleet Costs
  - Payload per Truck
  - Energy Efficiency
  - Emissions
  - Safety

Task 7 Generalized Benefits/Cost Analysis

- Deliverables
  - Tech Memo, Delivery Date

Task 8 – Cost Recovery Structure Development

- Develop Cost Recovery Structure to Fund Repairs to Roads Utilized by OW Vehicles
- Rider 36 Utilized for Quantification of Accelerated Consumption Costs by Alternative Vehicle Configurations

Task 8 - Cost Recovery Structure Development

- Summarize State Used of Weight Distance Tax in US via
  - State Fuel Taxes
  - Truck Registration Fees
  - Truck Sales Tax
  - Truck Tire Sales Taxes
  - Overweight Truck Permit Fees
  - Alternative Tools

Task 8 - Cost Recovery Structure Development

- Explore Other Overweight Truck Recovery Methods
  - Internationally
  - Texas Motor Transportation Association
- Summarize Findings
  - Provide a List of Feasible Options with Benefits, Disbenefits, Technical Challenges, & Assessment of Direct Relationship between Revenue Source and Cost Recovery Method

Task 8 - Cost Recovery Structure Development

- Deliverables
  - Tech Memo, Delivery Date

Task 9 - Workshop

- Objective – To Inform and Train Truck Manufacturers and Operators on Study Findings
- Provide a Survey to Assess the Usefulness of the Workshop and Effectiveness of Presenters
- Deliverables
  - Workshop Presentation
  - Attendance Sheet
  - Completed Surveys
  - Workshop Discussion Notes
  - Research Report
  - Project Summary Report

Task 10 – Case Study Development

- Select Freight Corridor in Texas
  - Selected to Accommodate OS/OW Vehicles
    - Evaluate Potential Regulatory Issues
    - Conduct Economic Analysis of Potential Implementation
- Develop Implementation of the Findings of this Study
  - Guidelines for Implementation of Cost Recovery Fee Schedule From Task 8
- Identify the Main Potential Barriers for Implementation and Provide Potential Solutions/Approaches

Task 10 - Case Study Development

- Deliverables
  - Case Study Guidelines

ADD Project Schedule HERE

Presentation on Trends in Truck Configurations by

MR. JOHN WOODROOFFE

- Mr. Woodrooffe's Presentation Here

BREAK TIME

INFRASTRUCTURE-FRIENDLIER TRUCKS FORUM

Review and Evaluation of Current Gross Vehicle Weights and Axle Load Limits

TxDOT Project No. 0-6817

Project update

02/27/2015

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COLLABORATE. INNOVATE. EDUCATE.

UTSA

Contents

- Introduction
- Truck configurations
- Pavement consumption analysis
  - Methodology
  - Mechanistic empirical analysis
- Results and comparative analysis
- Conclusions

Introduction

- Main objectives
  - Identify alternative vehicle configurations
  - Perform mechanistic empirical analysis on selected pavements
  - Compare the pavement consumption of each alternative vehicle with base vehicle configuration
  - Identify infrastructure friendlier vehicles

Truck configurations

- Identified 18 vehicle configurations
  - USDOT study
  - TxDOT LCV study (0-6095)
  - Original contract
- Conventional vehicle configurations
  - Currently used in other countries/states
- Non-conventional vehicle configurations
  - Not commercially available

Truck configurations

Scenario	Veh #No.	Dimensions	# Axles	GVW (lbs)	Tractor				Semi-Trailer/ Trailer #1			Semi-Trailer/ Trailer #2			Semi-Trailer/ Trailer #3		
					Steer	Non-steer											
					Single	Single	Tandem	Tridem	Single	Tandem	Tridem	Single	Tandem	Tridem	Single	Tandem	Tridem
Base Case	1	Outer bridge 51ft	5	80,000	12,000		34,000			34,000							
A	2	Outer bridge 51ft	5	88,000	12,000		38,000			38,000							
B	3	Axle spacing 14ft & 35 ft	6	90,000	12,000		36,000				42,000						
	4		6	90,000	12,000		42,000				36,000						
	5		6	97,000	7,000		36,000				54,000						
C	6	Outer bridge 51ft	6	91,000	7,000			48,000		36,000							
	7		6	97,000	12,000			51,000		34,000							
	8		6	97,000	12,000			45,000		40,000							
D	9	Outer bridge 51ft	6	97,000	12,000			51,000	2 X 17,000								
	10		6	57,000	12,000			45,000	2 X 20,000								
E	11	28 or 28.5 ft trailers	6	97,000	11,000		26,000		20,000			2 X 20,000					
	12		6	80,000	11,000		18,000		17,000			2 X 17,000					
F	13	33 ft trailers	6	97000	11,000		26,000		20000			2 X 20,000					
	14		6	80000	11,000		18,000		17000			2 X 17,000					
G	15	Axle spacing 18ft; 41ft; 19ft; 41ft	9	138,000	10,000		32,000			32,000			2 X 32,000				
	16		9	90,000	10,000		20,000			20,000			2 X 20,000				
H	17	28 or 28.5 ft trailers	7	106000	11000		20000		15000			2 X 15,000			2 X 15,000		
I	18	28 or 28.5 ft trailers	10	129,000	12,000	11,000				28,000		11,000	28,000		11,000	28,000	

Truck configurations

Scenario: Base vehicle and A (with higher load)

Scenario: B

Truck configurations

Scenario: C

Scenario: D

Truck configurations

Scenario: E & F

Scenario: G

Scenario: H

Pavement consumption analysis

- Employed AASHTO's ME Design™ Version 2.1 software
- Pavement consumption
  - Number of passes each vehicle require to fully consume the pavement structure at the end of design life
  - Time required by each vehicle to fully consume the pavement structure under design traffic volume

Pavement consumption analysis

- Failure criteria:
  - 0.5 inches of rutting (surface deformation) at the end of the design life;
  - 10% of the cracked area (fatigue cracking associated with load) at the end of the design life;
  - 125 inches/mile of roughness in terms of the International Roughness Index (IRI) at the end of the design life (an initial IRI of 63 inches/mile was used in the analysis).

Pavement consumption analysis

- Equivalent Consumption Factor (ECF)

$$\frac{\#\ Passes\ of\ single\ axle\ with\ 18\ kips\ for\ full\ consumption}{\#\ Passes\ of\ a\ vehicle\ for\ full\ consumption}$$

Or

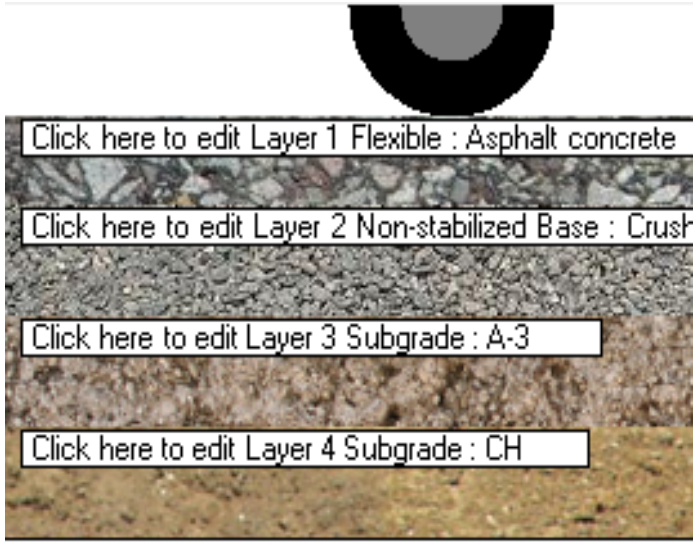
$$\frac{Pavement\ life\ for\ N\ passes\ of\ vehicle\ of\ interest}{Pavement\ life\ for\ N\ passes\ of\ single\ axle\ with\ 18\ kips\ load}$$

Where *N* = Total number of passes during design life

Pavement consumption analysis

- Pavement structure does influence the ECF
- Identified more than 100 pavement sections
  - Flexible
  - Concrete
  - Surface treatments
- Randomly selected a pavement section for the preliminary analysis in Task 3

Pavement consumption analysis



- Thickness of the asphalt concrete (Layer 1): 8 inch
- Thickness of the Non-stabilized base (Layer 2): 10 inch
- Thickness of the Subgrade (Layer 3): 10 inch
- Thickness of the Subgrade (Layer 4): Semi-infinite

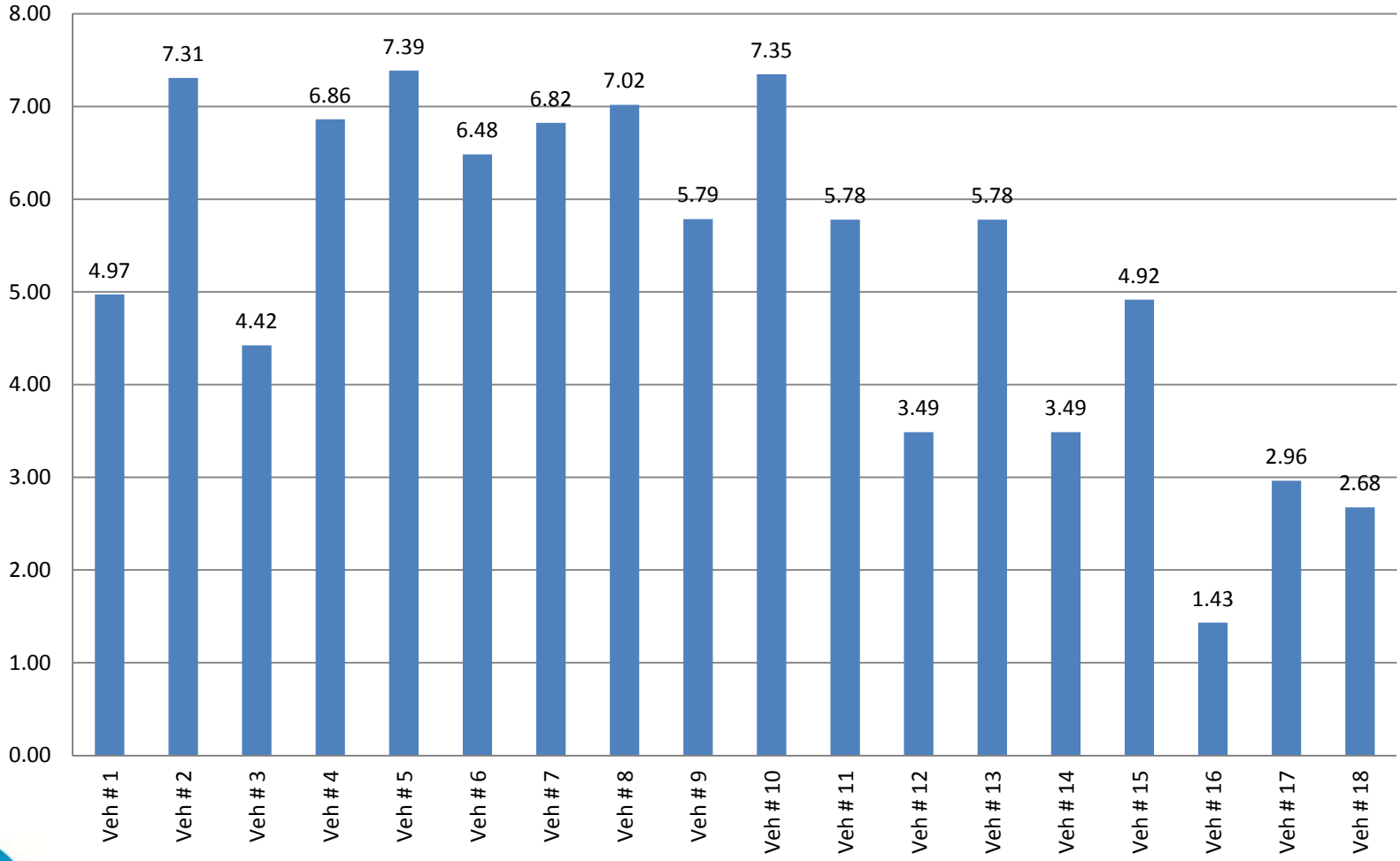
Results and comparative analysis

- Estimated ECF for experimental vehicles
  - Rutting, cracking, IRI
  - Averaged ECF
- Normalized pavement consumption (ECF) per unit transport load
- Relative normalized ECF with reference to base vehicle

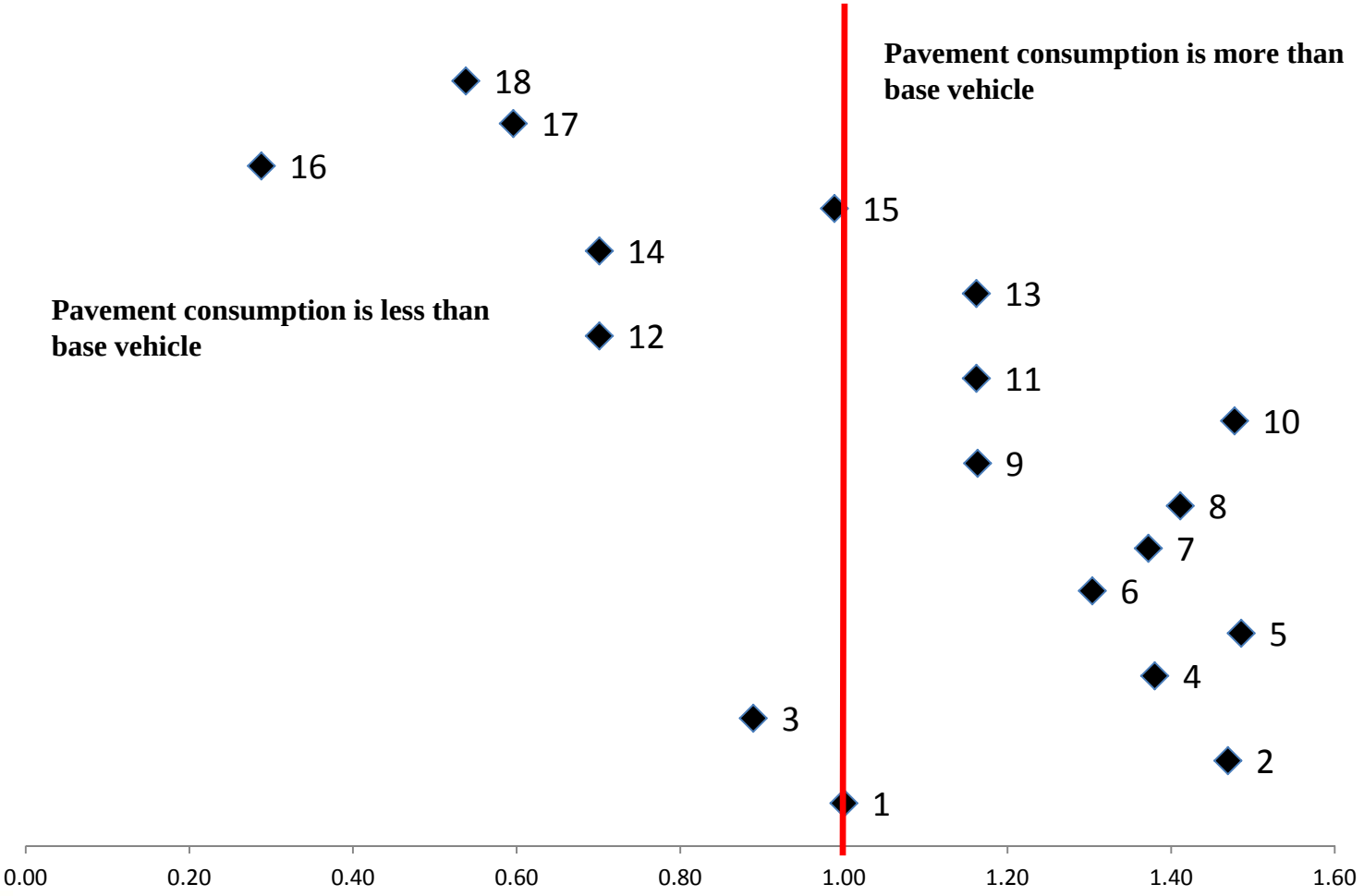
Results and comparative analysis

Scenario	Veh #No.	Dimensions	# Axles	GVW (lbs)	ECF: Rutting			ECF: Cracking			ECF: IRI			ECF: Total		
					ECF	ECF per unit GVW	Relative to base case	ECF	ECF per unit GVW	Relative to base case	ECF	ECF per unit GVW	Relative to base case	ECF	ECF per unit GVW	Relative to base case
Base Case	1	Outer bridge 51ft	5	80,000	7.74	9.68	1.00	2.05	2.56	1.00	2.14	2.68	1.00	3.98	4.97	1.00
A	2	Outer bridge 51ft	5	88,000	13.33	15.15	1.57	3.20	3.64	1.42	2.76	3.13	1.17	6.43	7.31	1.47
B	3	Axle spacing 14ft & 35 ft	6	90,000	8.28	9.20	0.95	1.58	1.75	0.68	2.09	2.32	0.87	**3.98**	**4.42**	**0.89**
	4		6	90,000	13.33	14.81	1.53	2.70	3.00	1.17	2.50	2.78	1.04	6.18	6.86	1.38
	5		6	97,000	16.00	16.49	1.70	2.50	2.58	1.01	3.00	3.09	1.15	7.17	7.39	1.49
C	6	Outer bridge 51ft	6	91,000	13.33	14.65	1.51	1.97	2.16	0.84	2.40	2.64	0.98	5.90	6.48	1.30
	7		6	97,000	15.00	15.46	1.60	2.16	2.23	0.87	2.70	2.78	1.04	6.62	6.82	1.37
	8		6	97,000	15.00	15.46	1.60	2.70	2.78	1.08	2.73	2.81	1.05	6.81	7.02	1.41
D	9	Outer bridge 51ft	6	97,000	10.91	11.25	1.16	3.20	3.30	1.29	2.73	2.81	1.05	5.61	5.79	1.16
	10		6	57,000	8.89	15.59	1.61	0.82	1.44	0.56	2.86	5.01	1.87	4.19	7.35	1.48
E	11	28 or 28.5 ft trailers	6	97,000	8.00	8.25	0.85	5.85	6.03	2.35	2.96	3.05	1.14	5.61	5.78	1.16
	12		6	80,000	3.75	4.69	0.48	2.76	3.45	1.34	1.86	2.33	0.87	**2.79**	**3.49**	**0.70**
F	13	33 ft trailers	6	97000	8.00	8.25	0.85	5.85	6.03	2.35	2.96	3.05	1.14	5.61	5.78	1.16
	14		6	80000	3.75	4.69	0.48	2.76	3.45	1.34	1.86	2.33	0.87	**2.79**	**3.49**	**0.70**
G	15	Axle spacing 18ft; 41ft;	9	138,000	14.12	10.23	1.06	3.12	2.26	0.88	3.12	2.26	0.84	**6.78**	**4.92**	**0.99**
	16	19ft; 41ft	9	90,000	2.14	2.38	0.25	0.50	0.56	0.22	1.22	1.36	0.51	**1.29**	**1.43**	**0.29**
H	17	28 or 28.5 ft trailers	7	106000	4.53	4.27	0.44	2.79	2.63	1.03	2.11	1.99	0.74	**3.14**	**2.96**	**0.60**
I	18	28 or 28.5 ft trailers	10	129,000	6.32	4.90	0.51	1.88	1.45	0.57	2.16	1.68	0.63	**3.45**	**2.68**	**0.54**

Results and comparative analysis



Results and comparative analysis



Conclusions

- Identified 18 vehicle configurations
- Estimated equivalent pavement consumption
- Data suggests that LCV scenarios are pavement friendlier
- Analysis will be extended to other pavement sections in future

THANK YOU !

Infrastructure-Friendlier Trucks Forum

- Goal of Forum – To Attain Input from the Industry on Limitations for Non-Conventional Vehicle Configurations, and Discuss Potential Benefits and Costs Related to Changes in TS&W Regulations
- Layout
  - Present Results of Phone Interview Efforts
  - Group Discussion (4 Questions)

Infrastructure-Friendlier Trucks Forum

- Phone Interview Results

Infrastructure-Friendlier Trucks Forum

Discussion Question #1

What Are Some Limitation of
Non-Conventional Vehicle Configurations
(i.e., Single, Tandem, Tridem, Quad-Axle)?

Infrastructure-Friendlier Trucks Forum

Discussion Question #2

What Are Some Potential Benefits & Costs Related to Changes in TS&W?

Infrastructure-Friendlier Trucks Forum

Discussion Question #2

What Are Some Potential Benefits & Costs Related to Changes in TS&W?

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Discussion Question #3

What Are Some Overweight/Oversize Load Issues and Challenges?

Infrastructure-Friendlier Trucks Forum

Discussion Question #4

What Are the Next Steps You See for Texas?