SLA Truck Configuration Library Final Report

To:	Blake Calvert
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Chapter 1 Goals and Objectives of the SLA Truck Configuration Library

1.1 Introduction

Historically, the Texas Department of Transportation (TxDOT) State Legislative Affairs (SLA) Section, TxDOT subject matter experts (SME) and the University of Texas – Center for Transportation Research (CTR) and University of Texas – San Antonio (UTSA) researchers have responded to complex questions from the legislature about impacts of proposed changes to truck size and weight during the legislative session. Due to the fast-paced nature of legislative sessions, often information is requested on short notice and timeframes that leave little time to conduct a sufficiently detailed analysis in recognition of the importance and long term potential effects of the legislature. For this reason, TxDOT SLA contracted with UT-CTR early in 2016 to develop a Truck Configuration Library with pavement and bridge consumption costs that would provide SLA and TxDOT SME with information to respond to legislative questions.

To provide information about trucking industry interests in changes to truck size and weight, SLA, TxDOT SME, UT-CTR and UTSA conducted two workshops with trucking industry to gain insights about the weights and configurations that were planned to be presented during the upcoming FY 17 Legislative Session. Additional interviews with the Texas Department of Motor Vehicles, Motor Carrier Division, Vehicle Titles and Registration Division, the Texas Department of Public Safety and one-on-one discussions with trucking industry representatives provided valuable insights. The workshops, meetings with SLA and TxDOT SME and the Truck

Configuration Library are the primary deliverables from this contract. The following sections briefly explain goals and objectives, the organization and the outcomes of this study.

1.2 Study Framework

Figure 1.1 shows the relationship between the seven tasks that were performed under this study. Task 1 and 5 consisted of Workshops with the trucking industry to obtain information about changes to truck size and weight laws that would benefit different truck freight and economic sectors. Summaries of the main ideas from each Workshop were documented to provide SLA, TxDOT SME and the research team with information about truck types and configurations to include in the Truck Configuration Library. Task 2 involved a discussion of the results of Workshop I and a preliminary list of truck operation and configuration types for pavement and consumption analysis in Tasks 3 and 4. A draft Truck Configuration Library was delivered to SLA on June 30th for review and comment.

The draft Truck Configuration Library concept was presented during Workshop II along with preliminary pavement and bridge consumption analysis results. Additional truck operational types and configurations were identified from the Workshop and during meetings with Senator Robert Nichols, members of his staff, TxDOT, TxDMV and members of the research team. Based on meetings with Senator Nichols and later contacts with the trucking industry, the following truck operational and configuration types were identified for potential further analysis:

1. 90,000 lb 6-axle livestock truck (not evaluated) Workshop II and follow up contacts with the Texas Cattle Feeders Association
2. 90,000 lb 6-axle grain truck (not evaluated) Workshop II and follow up contacts with the Texas Cattle Feeders Association
3. 95,000 lb or 97,000 lb milk tank trailer (not evaluated) Workshop II
4. Multiple configurations for a 97,000 lb heavy weight container truck considering designs in operation at the Heavy Weight Container Corridor; Longbeach, California and on the I-5 heavy container corridor in Tacoma, Washington State. Meetings with Senator Nichols and members of his staff - Analyzed and included in the Truck Configuration Library

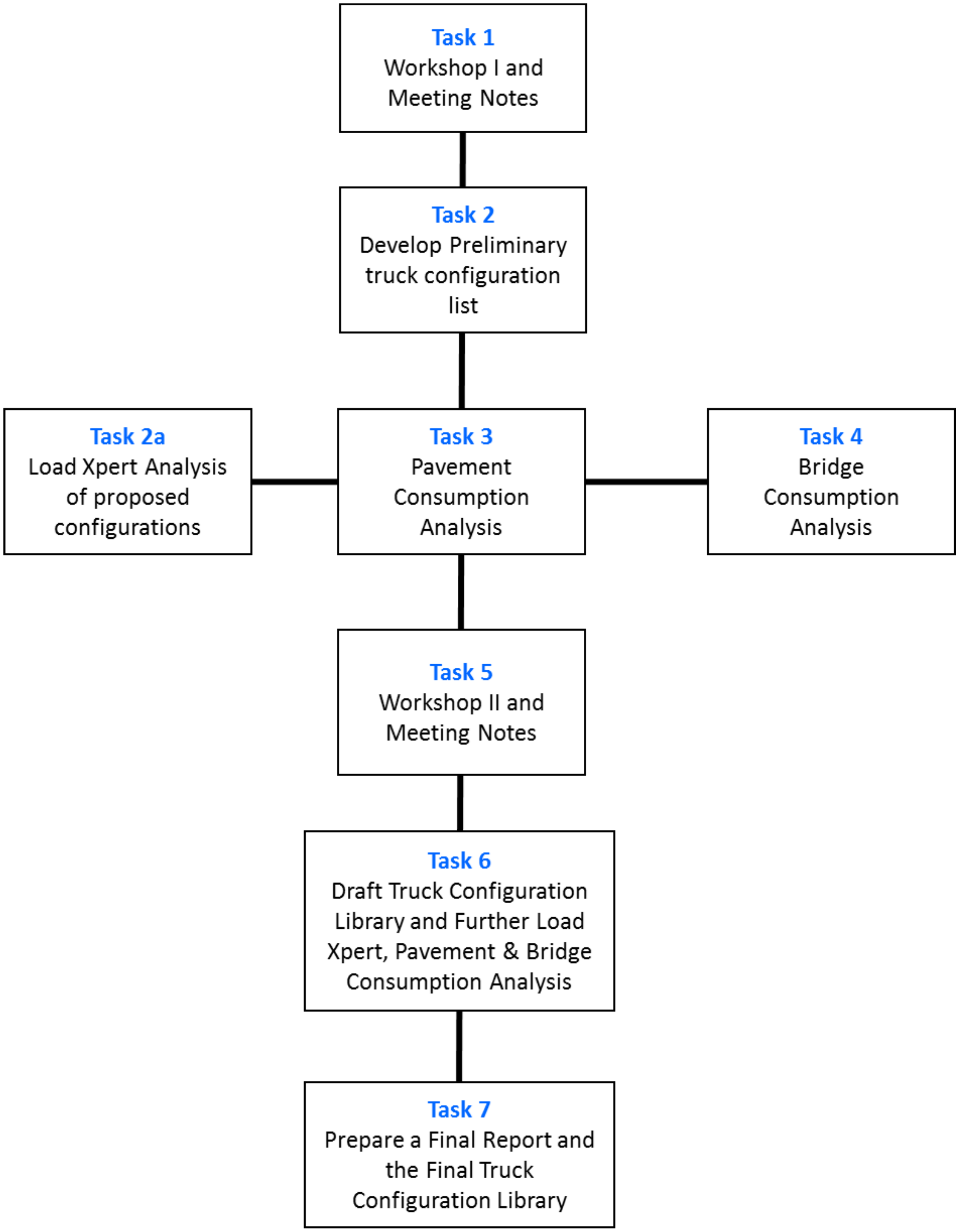


Figure 1.1: Study framework showing major tasks and deliverables

The results of the Workshops, the pavement and bridge consumption analyses and preparation of the Truck Configuration Library are discussed in more detail in the following Chapters.

Chapter 2 Workshop I and Discussion Results

Workshop I was held from 9:30 to 11:00 AM on February 29, 2016 at the TxDOT Dewitt C. Greer Building, Commission Meeting Room. Seventy-two representatives from trucking industry associations, city and state agencies, TxDOT, TxDMV, TxDPS, the Houston Police Department, and CTR/UTSA attended this workshop. A list of all Workshop I attendees can be found in Appendix A.

The main purpose of this workshop was gathering information about the truck configurations and weight limits of interest to the trucking industry. This information supplemented configurations described in draft bills considered by the legislature during the previous session and provided the initial set of draft configurations for further discussion with TxDOT.

The CTR/UTSA research team presented the study goals and objectives, data needs and methodologies for bridge and pavement consumption analysis. The presentation slides are attached as Appendix B. During the presentation, Dr. Mike Murphy presented examples of different container chassis and container size combinations to illustrate the fact that there can be many possible configurations. He also presented ready mix truck and milk tank truck configurations to encourage comments from the audience. Dr. Jorge Prozzi explained the pavement consumption analysis process which was of great interest to the group. In addition, Dr. Jose Weissmann presented the bridge consumption analysis process and solicited questions from the audience regarding the analysis approach.

After the presentations a discussion session was held with the audience. The purpose of this discussion session was to facilitate open discussions with industry regarding truck configurations and operational considerations that would affect load distribution and the ability of the driver to adjust load among axles and axle groups. The audience was also invited to ask questions about how this data would be used to develop the Truck Configuration Library.

The major discussion results of this workshop are:

- Certain configurations of container trucks, milk tank trucks and ready mix trucks will be included in the OS/OW truck configuration library. Oil Well Servicing vehicles were excluded from the analysis though a bill had been introduced regarding a proposed new permit in the previous legislative session. The researchers and TxDOT bridge engineers had found that over 50% of bridges in the state would require load posting for many of the Oil Well Service Rig configurations that were analyzed which was considered infeasible.
- The research team invited the industry to provide input regarding additional types of trucks or truck configurations for further consideration and possible inclusion in the Library.
- The possible reduction in the number of trucks transporting a given amount of cargo, due to a proposed increase of the weight limit increase, will not be considered in this analysis due to the scope of this study and the complexity of the problem.

- TxDOT will use the Library and CTR/UTSA research team's analysis results as reference to provide information for the legislature to support decisions.

Detailed summary notes of the presentations and discussions held during this workshop are attached as Appendix C. This workshop helped prepare the research team an unexpected series of meetings with Senator Robert Nichols and members of his staff regarding the CTR/UTSA analysis method and proposed heavy weight container configurations.

Chapter 3 Development of the Truck Configuration Library

3.1 Overview of the Truck Configuration Library

An Excel-based Truck Configuration Library was developed to store and manage data and findings regarding the selection of truck types and configurations, truck dimension and load distribution, and pavement and bridge consumption rates. The Library consists of two types of information sheets: 1) a summary sheet and 2) detailed information sheets for every selected truck configurations, as shown in Figure 3.1.

The summary sheet provides an overview of truck dimension/weight and consumption analyses for 51 configurations of container trucks, 5 configurations of Milk Tank Trucks, and 13 configurations of Ready Mix Trucks, including

- Truck Configuration ID
- Truck Description
- Truck Weight and Dimension
- If comply with Bridge Formula B
- Pavement and bridge consumption rates - Statewide
- Container trucks
    - Pavement and bridge consumption rates – Harris county
    - Pavement and bridge consumption rates – High functional class routes in Harris county
- Ready Mix Trucks
    - Pavement and bridge consumption rates – Top 20 Counties of Registered Ready Mix Tucks

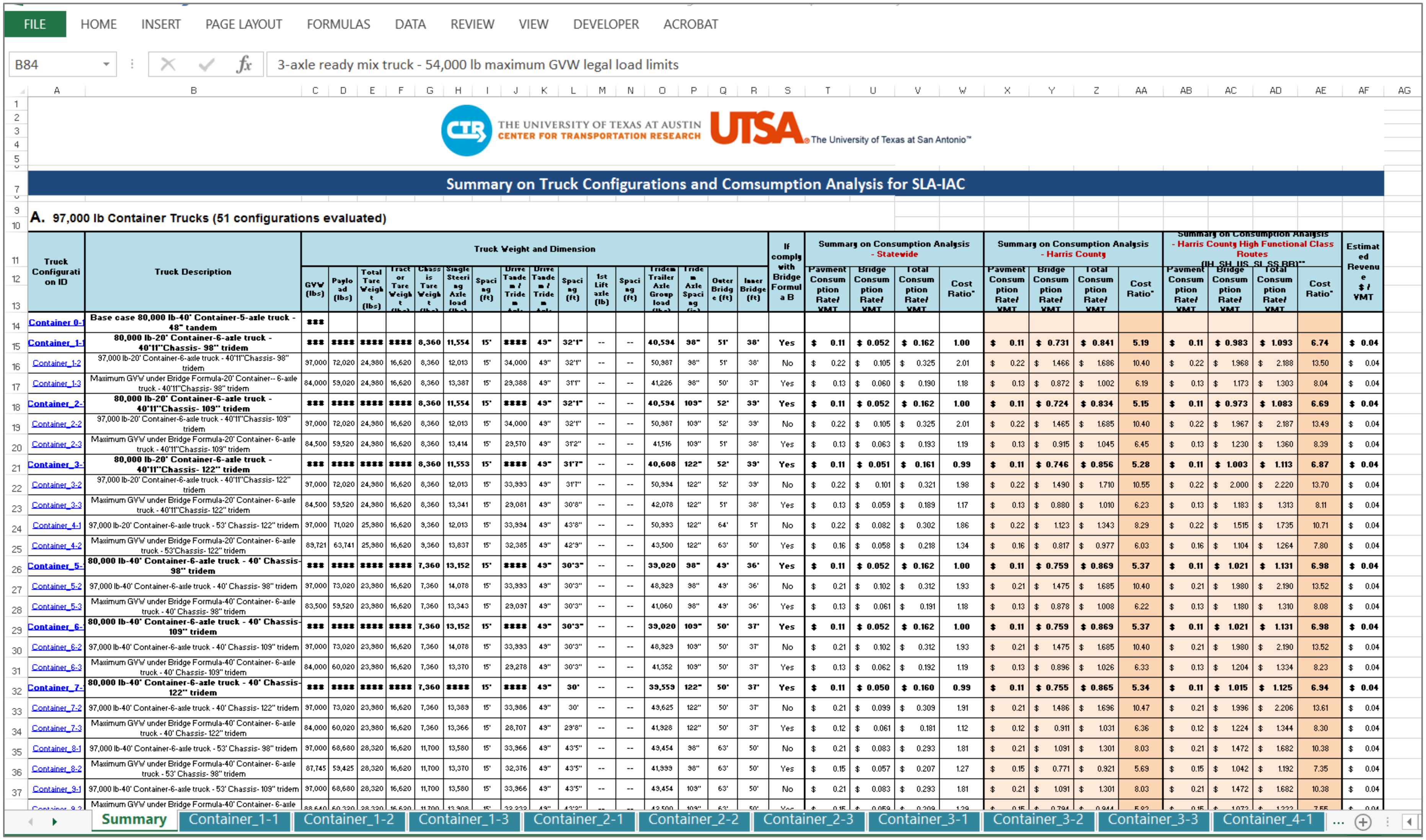
For each configuration, a hyperlink is provided to direct users to the detailed information sheet of the configuration. Table 3.1 – 3.3 list configurations analyzed for the container trucks, milk tank trucks, and ready mix trucks.

Base case

The team reviewed results and feedback from previous sessions and discussed with TxDOT subject matter experts (SMEs) to determine the base case for each truck group. For Container Trucks, configuration Container_0 is the base case and consists of an 80,000 lb 5-axle tractor semi-trailer with 40' container, which is with legal axle weights and spacing and Federal Bridge Formula B compliant. Consumption rates of the rest 50 container truck configurations were compared with the total statewide consumption rate of the base case Container 0_1 and calculated as the cost ratio.

For Milk Tank Trucks, configuration MilkTank_1-1 is the base case and consists of a Bridge Formula compliant 80,000 lb GVW 5-axle tractor semi-trailer. For Ready Mix Trucks, configuration ReadyMix_1-1 is the base case and consists of a 54,000 lb 3-axle legal loaded ready mix truck. Within both groups, comparisons to the total statewide consumption rate of each base case were conducted.

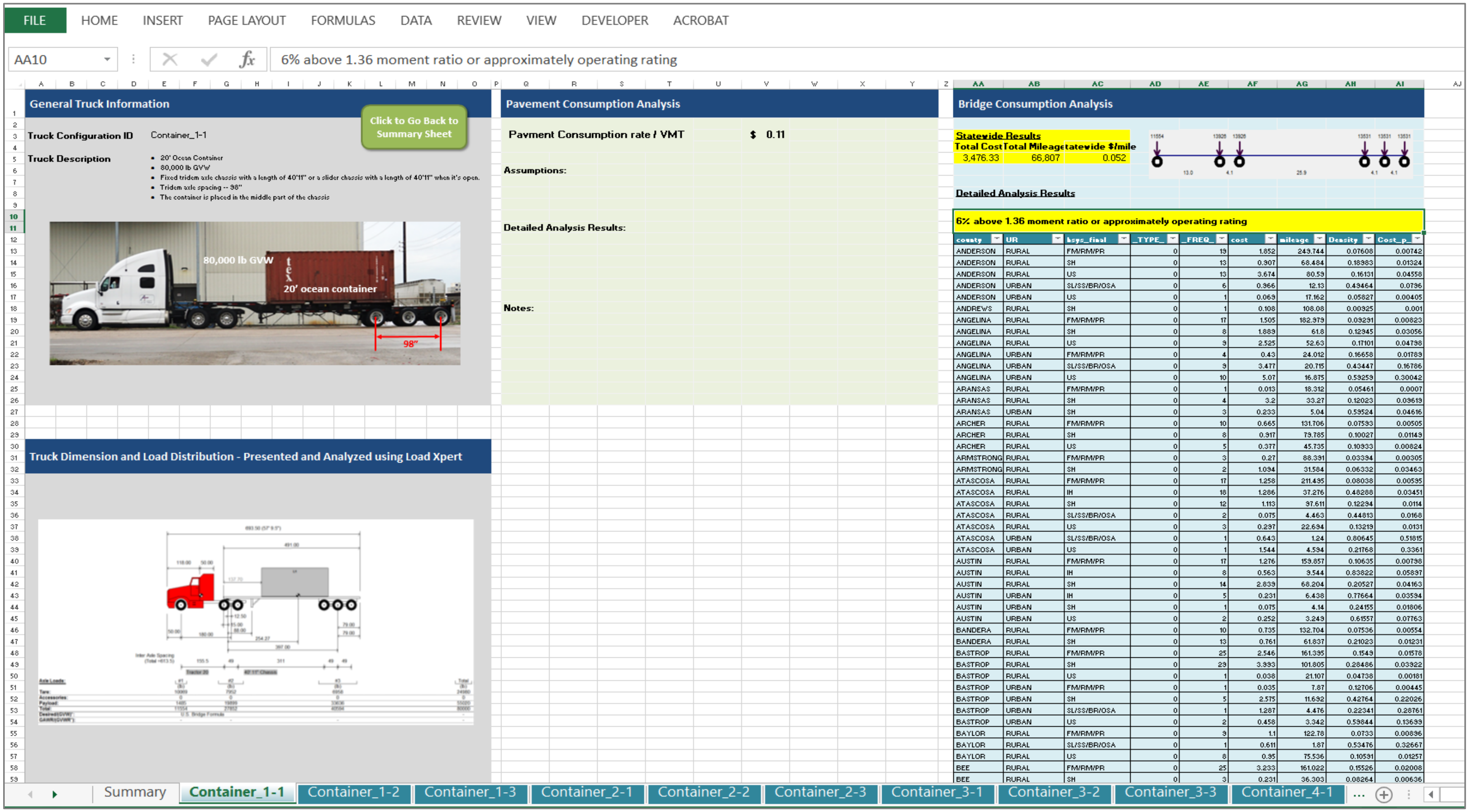
Detailed Information Sheets documents pavement and bridge consumption rates. Bridge analysis results include consumption rates of five highway systems at county level in both rural and urban areas, and the percentage of bridges that is above 1.36 moment ratio or approximately operating rating. Additionally, each sheet presents an example truck and drawings from Load Xpert with detailed information on truck dimension and how load is distributed. The part also discusses whether a configuration comply with Federal Bridge Formula B and highlights axle group(s) that violate the Formula B if there is any.



Truck Configuration ID	Truck Description	GVW (lbs)	Payload (lbs)	Total Tare Weight (lbs)	Tractor Tare Weight	Chassis Tare Weight	Single Steering Axle load	Spacing (ft)	Drive Tandem / Tridem Axle	Drive Tandem / Tridem	Spacing (ft)	1st Lift axle (lb)	Spacing (ft)	Tridem Trailer Axle Group load	Tridem Axle Spacing	Outer Bridge (ft)	Inner Bridge (ft)	If comply with Bridge Formula B
Container 0-1	**Base case 80,000 lb-40' Container-5-axle truck - 48" tandem**	###																
Container_1-1	**80,000 lb-20' Container-6-axle truck - 40'11"Chassis- 98" tridem**	###	####	####	####	8,360	11,554	15'	####	49"	32'1"	--	--	40,594	98"	51'	38'	Yes
Container_1-2	97,000 lb-20' Container-6-axle truck - 40'11"Chassis- 98" tridem	97,000	72,020	24,980	16,620	8,360	12,013	15'	34,000	49"	32'1"	--	--	50,987	98"	51'	38'	No
Container_1-3	Maximum GVW under Bridge Formula-20' Container-- 6-axle truck - 40'11"Chassis- 98" tridem	84,000	59,020	24,980	16,620	8,360	13,387	15'	29,388	49"	31'1"	--	--	41,226	98"	50'	37'	Yes
Container_2-1	**80,000 lb-20' Container-6-axle truck - 40'11"Chassis- 109" tridem**	###	####	####	####	8,360	11,554	15'	####	49"	32'1"	--	--	40,594	109"	52'	39'	Yes
Container_2-2	97,000 lb-20' Container-6-axle truck - 40'11"Chassis- 109" tridem	97,000	72,020	24,980	16,620	8,360	12,013	15'	34,000	49"	32'1"	--	--	50,987	109"	52'	39'	No
Container_2-3	Maximum GVW under Bridge Formula-20' Container- 6-axle truck - 40'11"Chassis- 109" tridem	84,500	59,520	24,980	16,620	8,360	13,414	15'	29,570	49"	31'2"	--	--	41,516	109"	51'	38'	Yes
Container_3-1	**80,000 lb-20' Container-6-axle truck - 40'11"Chassis- 122" tridem**	###	####	####	####	8,360	11,553	15'	####	49"	31'7"	--	--	40,608	122"	52'	39'	Yes
Container_3-2	97,000 lb-20' Container-6-axle truck - 40'11"Chassis- 122" tridem	97,000	72,020	24,980	16,620	8,360	12,013	15'	33,993	49"	31'7"	--	--	50,994	122"	52'	39'	No
Container_3-3	Maximum GVW under Bridge Formula-20' Container- 6-axle truck - 40'11"Chassis- 122" tridem	84,500	59,520	24,980	16,620	8,360	13,341	15'	29,081	49"	30'8"	--	--	42,078	122"	51'	38'	Yes
Container_4-1	97,000 lb-20' Container-6-axle truck - 53' Chassis- 122" tridem	97,000	71,020	25,980	16,620	9,360	12,013	15'	33,994	49"	43'8"	--	--	50,993	122"	64'	51'	No
Container_4-2	Maximum GVW under Bridge Formula-20' Container- 6-axle truck - 53'Chassis- 122" tridem	89,721	63,741	25,980	16,620	9,360	13,837	15'	32,385	49"	42'9"	--	--	43,500	122"	63'	50'	Yes
Container_5-1	**80,000 lb-40' Container-6-axle truck - 40' Chassis- 98" tridem**	###	####	####	####	7,360	13,152	15'	####	49"	30'3"	--	--	39,020	98"	49'	36'	Yes
Container_5-2	97,000 lb-40' Container-6-axle truck - 40' Chassis- 98" tridem	97,000	73,020	23,980	16,620	7,360	14,078	15'	33,993	49"	30'3"	--	--	48,929	98"	49'	36'	No
Container_5-3	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 40' Chassis- 98" tridem	83,500	59,520	23,980	16,620	7,360	13,343	15'	29,097	49"	30'3"	--	--	41,060	98"	49'	36'	Yes
Container_6-1	**80,000 lb-40' Container-6-axle truck - 40' Chassis- 109" tridem**	###	####	####	####	7,360	13,152	15'	####	49"	30'3"	--	--	39,020	109"	50'	37'	Yes
Container_6-2	97,000 lb-40' Container-6-axle truck - 40' Chassis- 109" tridem	97,000	73,020	23,980	16,620	7,360	14,078	15'	33,993	49"	30'3"	--	--	48,929	109"	50'	37'	No
Container_6-3	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 40' Chassis- 109" tridem	84,000	60,020	23,980	16,620	7,360	13,370	15'	29,278	49"	30'3"	--	--	41,352	109"	50'	37'	Yes
Container_7-1	**80,000 lb-40' Container-6-axle truck - 40' Chassis- 122" tridem**	###	####	####	####	7,360	####	15'	####	49"	30'	--	--	39,559	122"	50'	37'	Yes
Container_7-2	97,000 lb-40' Container-6-axle truck - 40' Chassis- 122" tridem	97,000	73,020	23,980	16,620	7,360	13,389	15'	33,986	49"	30'	--	--	49,625	122"	50'	37'	No
Container_7-3	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 40' Chassis- 122" tridem	84,000	60,020	23,980	16,620	7,360	13,366	15'	28,707	49"	29'8"	--	--	41,928	122"	50'	37'	Yes
Container_8-1	97,000 lb-40' Container-6-axle truck - 53' Chassis- 98" tridem	97,000	68,680	28,320	16,620	11,700	13,580	15'	33,966	49"	43'5"	--	--	49,454	98"	63'	50'	No
Container_8-2	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 53' Chassis- 98" tridem	87,745	59,425	28,320	16,620	11,700	13,370	15'	32,376	49"	43'5"	--	--	41,999	98"	63'	50'	Yes
Container_9-1	97,000 lb-40' Container-6-axle truck - 53' Chassis- 109" tridem	97,000	68,680	28,320	16,620	11,700	13,580	15'	33,966	49"	43'5"	--	--	49,454	109"	63'	50'	No

Truck Configuration ID	Statewide: Pavment Consumption Rate/VMT	Statewide: Bridge Consumption Rate/VMT	Statewide: Total Consumption Rate/VMT	Statewide: Cost Ratio*	Harris County: Pavment Consumption Rate/VMT	Harris County: Bridge Consumption Rate/VMT	Harris County: Total Consumption Rate/VMT	Harris County: Cost Ratio*	Harris County High Functional Class Routes (IH, SH, US, SL, SS, BR)**: Pavment Consumption Rate/VMT	Harris County High Functional Class Routes: Bridge Consumption Rate/VMT	Harris County High Functional Class Routes: Total Consumption Rate/VMT	Harris County High Functional Class Routes: Cost Ratio*	Estimated Revenue $ / VMT
Container 0-1													
Container_1-1	**$ 0.11**	**$ 0.052**	**$ 0.162**	**1.00**	**$ 0.11**	**$ 0.731**	**$ 0.841**	**5.19**	**$ 0.11**	**$ 0.983**	**$ 1.093**	**6.74**	**$ 0.04**
Container_1-2	$ 0.22	$ 0.105	$ 0.325	2.01	$ 0.22	$ 1.466	$ 1.686	10.40	$ 0.22	$ 1.968	$ 2.188	13.50	$ 0.04
Container_1-3	$ 0.13	$ 0.060	$ 0.190	1.18	$ 0.13	$ 0.872	$ 1.002	6.19	$ 0.13	$ 1.173	$ 1.303	8.04	$ 0.04
Container_2-1	**$ 0.11**	**$ 0.052**	**$ 0.162**	**1.00**	**$ 0.11**	**$ 0.724**	**$ 0.834**	**5.15**	**$ 0.11**	**$ 0.973**	**$ 1.083**	**6.69**	**$ 0.04**
Container_2-2	$ 0.22	$ 0.105	$ 0.325	2.01	$ 0.22	$ 1.465	$ 1.685	10.40	$ 0.22	$ 1.967	$ 2.187	13.49	$ 0.04
Container_2-3	$ 0.13	$ 0.063	$ 0.193	1.19	$ 0.13	$ 0.915	$ 1.045	6.45	$ 0.13	$ 1.230	$ 1.360	8.39	$ 0.04
Container_3-1	**$ 0.11**	**$ 0.051**	**$ 0.161**	**0.99**	**$ 0.11**	**$ 0.746**	**$ 0.856**	**5.28**	**$ 0.11**	**$ 1.003**	**$ 1.113**	**6.87**	**$ 0.04**
Container_3-2	$ 0.22	$ 0.101	$ 0.321	1.98	$ 0.22	$ 1.490	$ 1.710	10.55	$ 0.22	$ 2.000	$ 2.220	13.70	$ 0.04
Container_3-3	$ 0.13	$ 0.059	$ 0.189	1.17	$ 0.13	$ 0.880	$ 1.010	6.23	$ 0.13	$ 1.183	$ 1.313	8.11	$ 0.04
Container_4-1	$ 0.22	$ 0.082	$ 0.302	1.86	$ 0.22	$ 1.123	$ 1.343	8.29	$ 0.22	$ 1.515	$ 1.735	10.71	$ 0.04
Container_4-2	$ 0.16	$ 0.058	$ 0.218	1.34	$ 0.16	$ 0.817	$ 0.977	6.03	$ 0.16	$ 1.104	$ 1.264	7.80	$ 0.04
Container_5-1	**$ 0.11**	**$ 0.052**	**$ 0.162**	**1.00**	**$ 0.11**	**$ 0.759**	**$ 0.869**	**5.37**	**$ 0.11**	**$ 1.021**	**$ 1.131**	**6.98**	**$ 0.04**
Container_5-2	$ 0.21	$ 0.102	$ 0.312	1.93	$ 0.21	$ 1.475	$ 1.685	10.40	$ 0.21	$ 1.980	$ 2.190	13.52	$ 0.04
Container_5-3	$ 0.13	$ 0.061	$ 0.191	1.18	$ 0.13	$ 0.878	$ 1.008	6.22	$ 0.13	$ 1.180	$ 1.310	8.08	$ 0.04
Container_6-1	**$ 0.11**	**$ 0.052**	**$ 0.162**	**1.00**	**$ 0.11**	**$ 0.759**	**$ 0.869**	**5.37**	**$ 0.11**	**$ 1.021**	**$ 1.131**	**6.98**	**$ 0.04**
Container_6-2	$ 0.21	$ 0.102	$ 0.312	1.93	$ 0.21	$ 1.475	$ 1.685	10.40	$ 0.21	$ 1.980	$ 2.190	13.52	$ 0.04
Container_6-3	$ 0.13	$ 0.062	$ 0.192	1.19	$ 0.13	$ 0.896	$ 1.026	6.33	$ 0.13	$ 1.204	$ 1.334	8.23	$ 0.04
Container_7-1	**$ 0.11**	**$ 0.050**	**$ 0.160**	**0.99**	**$ 0.11**	**$ 0.755**	**$ 0.865**	**5.34**	**$ 0.11**	**$ 1.015**	**$ 1.125**	**6.94**	**$ 0.04**
Container_7-2	$ 0.21	$ 0.099	$ 0.309	1.91	$ 0.21	$ 1.486	$ 1.696	10.47	$ 0.21	$ 1.996	$ 2.206	13.61	$ 0.04
Container_7-3	$ 0.12	$ 0.061	$ 0.181	1.12	$ 0.12	$ 0.911	$ 1.031	6.36	$ 0.12	$ 1.224	$ 1.344	8.30	$ 0.04
Container_8-1	$ 0.21	$ 0.083	$ 0.293	1.81	$ 0.21	$ 1.091	$ 1.301	8.03	$ 0.21	$ 1.472	$ 1.682	10.38	$ 0.04
Container_8-2	$ 0.15	$ 0.057	$ 0.207	1.27	$ 0.15	$ 0.771	$ 0.921	5.69	$ 0.15	$ 1.042	$ 1.192	7.35	$ 0.04
Container_9-1	$ 0.21	$ 0.083	$ 0.293	1.81	$ 0.21	$ 1.091	$ 1.301	8.03	$ 0.21	$ 1.472	$ 1.682	10.38	$ 0.04

(a) Summary sheet



(b) An example of detailed information sheets

Figure 3.1 Screen shot of the truck configuration library

Table 3.1: Container Truck Pavement and Bridge Consumption Rates

Truck Configuration ID	Truck Description	Summary on Consumption Analysis - Statewide				Summary on Consumption Analysis - Harris County				Summary on Consumption Analysis - Harris County High Functional Class Routes (IH, SH, US, SL,SS,BR)**				Estimated Revenue $ / VMT
		Pavement Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio*	Pavement Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio*	Pavement Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio*	
Container_0	**Base case 80,000 lb-40' Container-5-axle truck -48" tandem**	**$ 0.15**	**$ 0.030**	**$ 0.180**	**1.00**	--	--	--	--	--	--	--		**$0.04**
Container_1-1	**80,000 lb-20' Container-6-axle truck - 40'11"Chassis- 98" tridem**	**$ 0.11**	**$ 0.052**	**$ 0.162**	**0.90**	**$ 0.11**	**$ 0.731**	**$ 0.841**	**4.67**	**$ 0.11**	**$ 0.983**	**$ 1.093**	**6.07**	**$0.04**
Container_1-2	97,000 lb-20' Container-6-axle truck - 40'11"Chassis- 98" tridem	$ 0.22	$ 0.105	$ 0.325	1.81	$ 0.22	$ 1.466	$ 1.686	9.37	$ 0.22	$ 1.968	$ 2.188	12.16	$0.05
Container_1-3	Maximum GVW under Bridge Formula-20' Container-- 6-axle truck - 40'11"Chassis- 98" tridem	$ 0.13	$ 0.060	$ 0.190	1.06	$ 0.13	$ 0.872	$ 1.002	5.57	$ 0.13	$ 1.173	$ 1.303	7.24	$0.04
Container_2-1	**80,000 lb-20' Container-6-axle truck - 40'11"Chassis- 109" tridem**	**$ 0.11**	**$ 0.052**	**$ 0.162**	**0.90**	**$ 0.11**	**$ 0.724**	**$ 0.834**	**4.63**	**$ 0.11**	**$ 0.973**	**$ 1.083**	**6.02**	**$0.04**
Container_2-2	97,000 lb-20' Container-6-axle truck - 40'11"Chassis- 109" tridem	$ 0.22	$ 0.105	$ 0.325	1.81	$ 0.22	$ 1.465	$ 1.685	9.36	$ 0.22	$ 1.967	$ 2.187	12.15	$0.05
Container_2-3	Maximum GVW under Bridge Formula-20' Container- 6-axle truck - 40'11"Chassis- 109" tridem	$ 0.13	$ 0.063	$ 0.193	1.07	$ 0.13	$ 0.915	$ 1.045	5.81	$ 0.13	$ 1.230	$ 1.360	7.56	$0.04
Container_3-1	**80,000 lb-20' Container-6-axle truck - 40'11"Chassis- 122" tridem**	**$ 0.11**	**$ 0.051**	**$ 0.161**	**0.89**	**$ 0.11**	**$ 0.746**	**$ 0.856**	**4.75**	**$ 0.11**	**$ 1.003**	**$ 1.113**	**6.18**	**$0.04**
Container_3-2	97,000 lb-20' Container-6-axle truck - 40'11"Chassis- 122" tridem	$ 0.22	$ 0.101	$ 0.321	1.78	$ 0.22	$ 1.490	$ 1.710	9.50	$ 0.22	$ 2.000	$ 2.220	12.34	$0.05
Container_3-3	Maximum GVW under Bridge Formula-20' Container- 6-axle truck - 40'11"Chassis- 122" tridem	$ 0.13	$ 0.059	$ 0.189	1.05	$ 0.13	$ 0.880	$ 1.010	5.61	$ 0.13	$ 1.183	$ 1.313	7.30	$0.04
Container_4-1	**97,000 lb-20' Container-6-axle truck - 53' Chassis- 122" tridem**	**$ 0.22**	**$ 0.082**	**$ 0.302**	**1.68**	**$ 0.22**	**$ 1.123**	**$ 1.343**	**7.46**	**$ 0.22**	**$ 1.515**	**$ 1.735**	**9.64**	**$0.05**
Container_4-2	Maximum GVW under Bridge Formula-20' Container- 6-axle truck - 53'Chassis- 122" tridem	$ 0.16	$ 0.058	$ 0.218	1.21	$ 0.16	$ 0.817	$ 0.977	5.43	$ 0.16	$ 1.104	$ 1.264	7.02	$0.04
Container_5-1	**80,000 lb-40' Container-6-axle truck - 40' Chassis- 98" tridem**	**$ 0.11**	**$ 0.052**	**$ 0.162**	**0.90**	**$ 0.11**	**$ 0.759**	**$ 0.869**	**4.83**	**$ 0.11**	**$ 1.021**	**$ 1.131**	**6.28**	**$0.04**
Container_5-2	97,000 lb-40' Container-6-axle truck - 40' Chassis- 98" tridem	$ 0.21	$ 0.102	$ 0.312	1.73	$ 0.21	$ 1.475	$ 1.685	9.36	$ 0.21	$ 1.980	$ 2.190	12.17	$0.05
Container_5-3	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 40' Chassis- 98" tridem	$ 0.13	$ 0.061	$ 0.191	1.06	$ 0.13	$ 0.878	$ 1.008	5.60	$ 0.13	$ 1.180	$ 1.310	7.28	$0.04
Container_6-1	**80,000 lb-40' Container-6-axle truck - 40' Chassis- 109" tridem**	**$ 0.11**	**$ 0.052**	**$ 0.162**	**0.90**	**$ 0.11**	**$ 0.759**	**$ 0.869**	**4.83**	**$ 0.11**	**$ 1.021**	**$ 1.131**	**6.28**	**$0.04**
Container_6-2	97,000 lb-40' Container-6-axle truck - 40' Chassis- 109" tridem	$ 0.21	$ 0.102	$ 0.312	1.73	$ 0.21	$ 1.475	$ 1.685	9.36	$ 0.21	$ 1.980	$ 2.190	12.17	$0.05
Container_6-3	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 40' Chassis- 109" tridem	$ 0.13	$ 0.062	$ 0.192	1.07	$ 0.13	$ 0.896	$ 1.026	5.70	$ 0.13	$ 1.204	$ 1.334	7.41	$0.04
Container_7-1	**80,000 lb-40' Container-6-axle truck - 40' Chassis- 122" tridem**	**$ 0.11**	**$ 0.050**	**$ 0.160**	**0.89**	**$ 0.11**	**$ 0.755**	**$ 0.865**	**4.80**	**$ 0.11**	**$ 1.015**	**$ 1.125**	**6.25**	**$0.04**
Container_7-2	97,000 lb-40' Container-6-axle truck - 40' Chassis- 122" tridem	$ 0.21	$ 0.099	$ 0.309	1.72	$ 0.21	$ 1.486	$ 1.696	9.42	$ 0.21	$ 1.996	$ 2.206	12.26	$0.05
Container_7-3	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 40' Chassis- 122" tridem	$ 0.12	$ 0.061	$ 0.181	1.01	$ 0.12	$ 0.911	$ 1.031	5.73	$ 0.12	$ 1.224	$ 1.344	7.47	$0.04
Container_8-1	97,000 lb-40' Container-6-axle truck - 53' Chassis- 98" tridem	$ 0.21	$ 0.083	$ 0.293	1.63	$ 0.21	$ 1.091	$ 1.301	7.23	$ 0.21	$ 1.472	$ 1.682	9.35	$0.04
Container_8-2	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 53' Chassis- 98" tridem	$ 0.15	$ 0.057	$ 0.207	1.15	$ 0.15	$ 0.771	$ 0.921	5.12	$ 0.15	$ 1.042	$ 1.192	6.62	$0.04

Container_9-1	97,000 lb-40' Container-6-axle truck - 53' Chassis- 109'' tridem	$ 0.21	$ 0.083	$ 0.293	1.63	$ 0.21	$ 1.091	$ 1.301	7.23	$ 0.21	$ 1.472	$ 1.682	9.35	$0.05
Container_9-2	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 53' Chassis- 109'' tridem	$ 0.15	$ 0.059	$ 0.209	1.16	$ 0.15	$ 0.794	$ 0.944	5.25	$ 0.15	$ 1.073	$ 1.223	6.79	$0.04
Container_10-1	97,000 lb-40' Container-6-axle truck - 53' Chassis- 122'' tridem	$ 0.21	$ 0.078	$ 0.288	1.60	$ 0.21	$ 1.092	$ 1.302	7.23	$ 0.21	$ 1.474	$ 1.684	9.35	$0.05
Container_10-2	Maximum GVW under Bridge Formula-40' Container- 6-axle truck - 53' Chassis- 122'' tridem	$ 0.16	$ 0.058	$ 0.218	1.21	$ 0.16	$ 0.815	$ 0.975	5.42	$ 0.16	$ 1.101	$ 1.261	7.00	$0.04
Container_11-1	97,000 lb-40' Container-7-axle truck - 53' Chassis- 122'' tridem-liftable 6250 lbs	$ 0.18	$ 0.074	$ 0.254	1.41	$ 0.18	$ 1.121	$ 1.301	7.23	$ 0.18	$ 1.507	$ 1.687	9.37	$0.05
Container_11-2	Maximum GVW under Bridge Formula-40' Container-7-axle truck - 53' Chassis- 122'' tridem-liftable 6250 lbs	$ 0.16	$ 0.072	$ 0.232	1.29	$ 0.16	$ 1.089	$ 1.249	6.94	$ 0.16	$ 1.465	$ 1.625	9.03	$0.05
Container_12-1	97,000 lb-40' Container-7-axle truck - 53' Chassis- 122'' tridem-liftable 11000 lbs	$ 0.16	$ 0.071	$ 0.231	1.28	$ 0.16	$ 1.124	$ 1.284	7.13	$ 0.16	$ 1.517	$ 1.677	9.32	$0.05
Container_12-2	Maximum GVW under Bridge Formula-40' Container-7-axle truck - 53' Chassis- 122'' tridem-liftable 11000 lbs	$ 0.15	$ 0.070	$ 0.220	1.22	$ 0.15	$ 1.114	$ 1.264	7.02	$ 0.15	$ 0.983	$ 1.133	6.29	$0.05
Container_21-1	**80000lb-40' Container-MACK 6X4 tractor-53' DBN X11 tridem chassis**	**$ 0.11**	**$ 0.043**	**$ 0.156**	**0.87**	**$ 0.11**	**$ 0.340**	**$ 0.453**	**2.52**	**$ 0.11**	**$ 0.350**	**$ 0.463**	**2.57**	**$0.04**
Container_21-2	90000lb-40' Container-MACK 6X4 tractor-53' DBN X11 tridem chassis	$ 0.17	$ 0.068	$ 0.237	1.32	$ 0.17	$ 0.521	$ 0.690	3.83	$ 0.17	$ 0.535	$ 0.704	3.91	$0.04
Container_21-3	97000lb-40' Container-MACK 6X4 tractor-53' DBN X11 tridem chassis	$ 0.23	$ 0.086	$ 0.312	1.73	$ 0.23	$ 0.684	$ 0.909	5.05	$ 0.23	$ 0.702	$ 0.928	5.15	$0.05
Container_21-4	102000lb-40' Container-MACK 6X4 tractor-53' DBN X11 tridem chassis	$ 0.28	$ 0.105	$ 0.382	2.12	$ 0.28	$ 0.821	$ 1.097	6.10	$ 0.28	$ 0.842	$ 1.119	6.22	$0.05
Container_21-5	Max payload-40' Container-MACK 6X4 tractor-53' DBN X11 tridem chassis	$ 0.17	$ 0.059	$ 0.225	1.25	$ 0.17	$ 0.489	$ 0.655	3.64	$ 0.17	$ 0.503	$ 0.669	3.72	$0.04
Container_22-1	**80000lb-40' Container-MACK 8X6 tractor-53' DBN X11 tridem chassis**	**$ 0.09**	**$ 0.040**	**$ 0.129**	**0.72**	**$ 0.09**	**$ 0.320**	**$ 0.409**	**2.27**	**$ 0.09**	**$ 0.330**	**$ 0.419**	**2.33**	**$0.04**
Container_22-2	90000lb-40' Container-MACK 8X6 tractor-53' DBN X11 tridem chassis	$ 0.13	$ 0.064	$ 0.197	1.09	$ 0.13	$ 0.494	$ 0.627	3.48	$ 0.13	$ 0.508	$ 0.641	3.56	$0.04
Container_22-3	97000lb-40' Container-MACK 8X6 tractor-53' DBN X11 tridem chassis	$ 0.18	$ 0.081	$ 0.257	1.43	$ 0.18	$ 0.651	$ 0.827	4.59	$ 0.18	$ 0.669	$ 0.845	4.69	$0.05
Container_22-4	102000lb-40' Container-MACK 8X6 tractor-53' DBN X11 tridem chassis	$ 0.22	$ 0.098	$ 0.314	1.74	$ 0.22	$ 0.767	$ 0.982	5.45	$ 0.22	$ 0.788	$ 1.003	5.57	$0.05
Container_22-5	Max payload-40' Container-MACK 8X6 tractor-53' DBN X11 tridem chassis	$ 0.15	$ 0.075	$ 0.222	1.24	$ 0.15	$ 0.649	$ 0.796	4.42	$ 0.15	$ 0.668	$ 0.815	4.53	$0.05
Container_23-1	**80000lb-40' Container-MACK 6X4 tractor-51' DBN X11 tridem chassis**	**$ 0.11**	**$ 0.041**	**$ 0.152**	**0.84**	**$ 0.11**	**$ 0.354**	**$ 0.465**	**2.58**	**$ 0.11**	**$ 0.364**	**$ 0.475**	**2.64**	**$0.04**
Container_23-2	90000lb-40' Container-MACK 6X4 tractor-51' DBN X11 tridem chassis	$ 0.17	$ 0.062	$ 0.230	1.28	$ 0.17	$ 0.516	$ 0.683	3.80	$ 0.17	$ 0.530	$ 0.698	3.88	$0.04
Container_23-3	97000lb-40' Container-MACK 6X4 tractor-51' DBN X11 tridem chassis	$ 0.22	$ 0.083	$ 0.307	1.71	$ 0.22	$ 0.669	$ 0.894	4.96	$ 0.22	$ 0.688	$ 0.912	5.07	$0.05
Container_23-4	102000lb-40' Container-MACK 6X4 tractor-51' DBN X11 tridem chassis	$ 0.28	$ 0.095	$ 0.370	2.06	$ 0.28	$ 0.801	$ 1.077	5.98	$ 0.28	$ 0.823	$ 1.098	6.10	$0.05
Container_23-5	Max payload-40' Container-MACK 6X4 tractor-51' DBN X11 tridem chassis	$ 0.17	$ 0.062	$ 0.231	1.28	$ 0.17	$ 0.519	$ 0.688	3.82	$ 0.17	$ 0.534	$ 0.703	3.90	$0.04
Container_24-1	**80000lb-40' Container-MACK 8X6 tractor-51' DBN X11 tridem chassis**	**$ 0.08**	**$ 0.038**	**$ 0.122**	**0.68**	**$ 0.08**	**$ 0.338**	**$ 0.421**	**2.34**	**$ 0.08**	**$ 0.347**	**$ 0.430**	**2.39**	**$0.04**
Container_24-2	90000lb-40' Container-MACK 8X6 tractor-51' DBN X11 tridem chassis	$ 0.12	$ 0.060	$ 0.180	1.00	$ 0.12	$ 0.504	$ 0.625	3.47	$ 0.12	$ 0.519	$ 0.639	3.55	$0.04
Container_24-3	97000lb-40' Container-MACK 8X6 tractor-51' DBN X11 tridem chassis	$ 0.16	$ 0.079	$ 0.236	1.31	$ 0.16	$ 0.652	$ 0.809	4.50	$ 0.16	$ 0.670	$ 0.827	4.60	$0.05
Container_24-4	102000lb-40' Container-MACK 8X6 tractor-51' DBN X11 tridem chassis	$ 0.19	$ 0.090	$ 0.280	1.56	$ 0.19	$ 0.775	$ 0.965	5.36	$ 0.19	$ 0.796	$ 0.986	5.48	$0.05
Container_24-5	Max payload-40' Container-MACK 8X6 tractor-51' DBN X11 tridem chassis	$ 0.14	$ 0.077	$ 0.219	1.21	$ 0.14	$ 0.677	$ 0.818	4.55	$ 0.14	$ 0.695	$ 0.837	4.65	$0.05

* Compared with the total statewide consumption rate for Container_0.

**IH=Interstate, SH=State Highway, US=US Highway, SL=State Loop, SS=State Spur, BR= Business Route.

Table 3.2: Milk Tank Truck Pavement and Bridge Consumption Rates

Truck Configuration ID	Truck Description	Summary on Consumption Analysis				Estimated Revenue $ / VMT
		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**	
MilkTank_1-1	**5-axle tractor with 6,300 gallon tank trailer - 80,000 lbs GVW**	**$ 0.17**	**$ 0.043**	**$ 0.213**	**1.00**	$ 0.05
MilkTank_1-2	5-axle tractor with 6,500 gallon tank trailer - 84,000 lbs GVW - agricultural exemption (12% tolerance on one tandem)	$ 0.22	$ 0.052	$ 0.272	1.28	$ 0.05
MilkTank_2-1	5-axle tractor with 7,000 gallon tandem axle truck tractor tandem axle tank trailer - 90,000 lbs GVW	$ 0.28	$ 0.065	$ 0.345	1.62	$ 0.05
MilkTank_2-2	6-axle tractor with 7,000 gallon tridem axle tank trailer - 90,000 lbs GVW	$ 0.16	$ 0.061	$ 0.221	1.03	$ 0.05
MilkTank_2-3	6-axle tractor with 7,000 gallon trailer tridem axle tractor - 90,000 lbs GVW	$ 0.14	$ 0.068	$ 0.208	0.98	$ 0.05

* An effort has been made to meet legal axle or GVW limits - however, small tolerances were accepted within the weight tolerance allowed based on DPS roadside weighing procedures and agriculture axle weight tolerances.

** Compared with the total consumption rate for MilkTank_1-1.

Table 3.3: Ready Mix Truck Pavement and Bridge Consumption Rates

Truck Configuration ID	Truck Description	Summary on Consumption Analysis - Statewide				Summary on Consumption Analysis - Top 20 Counties of Registered Ready Mix Tucks ***				Estimated Revenue $ / VMT
		Pavement Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**	Pavement Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**	
ReadyMix_1-1	**3-axle ready mix truck - 54,000 lb maximum GVW legal load limits**	**$ 0.10**	**$ 0.021**	**$ 0.121**	**1.00**	**$ 0.10**	**$ 0.121**	**$ 0.221**	**1.83**	$ 0.07
ReadyMix_1-2	3-axle Ready Mix Truck - state exemption of 69,000 lb GVW 23,000 lb steer, 46,000 lb tandem max	$ 0.29	$ 0.057	$ 0.347	2.86	$ 0.29	$ 0.341	$ 0.631	5.21	$ 0.08
ReadyMix_1-3	3-axle Ready Mix Truck - Ready Mix Truck Permit 69,000 lb GVW exemption - (but up to 25,300 lb steer, 50,600 lb tandem)	$ 0.47	$ 0.085	$ 0.555	4.58	$ 0.47	$ 0.486	$ 0.956	7.89	$ 0.08
ReadyMix_2-1	SU-4 4-axle ready mix truck with 1 booster axle - 69,000 lbs state exemption	$ 0.20	$ 0.046	$ 0.246	2.03	$ 0.20	$ 0.323	$ 0.523	4.32	$ 0.08
ReadyMix_2-2	SU-4 4-axle ready mix truck with 1 pusher axle - 69,000 lbs state exemption	$ 0.28	$ 0.081	$ 0.361	2.98	$ 0.28	$ 0.470	$ 0.750	6.19	$ 0.08
ReadyMix_2-3	SU-4 4-axle ready mix truck with 1 pusher axle - 70,100 lbs	$ 0.31	$ 0.087	$ 0.397	3.28	$ 0.31	$ 0.501	$ 0.811	6.69	$ 0.09
ReadyMix_2-4	SU-4 4-axle ready mix truck with 1 booster axle - 70,100 lbs	$ 0.23	$ 0.052	$ 0.282	2.33	$ 0.23	$ 0.371	$ 0.601	4.96	$ 0.09
ReadyMix_3-2	SU-5 5-axle ready mix truck with 1 pusher axle and 1 booster axle - 69,000 lbs state exemption	$ 0.17	$ 0.048	$ 0.218	1.80	$ 0.17	$ 0.332	$ 0.502	4.14	$ 0.09
ReadyMix_3-3	SU-5 5-axle ready mix truck with 1 pusher axle and 1 booster axle - 70,500 lbs	$ 0.15	$ 0.051	$ 0.201	1.66	$ 0.15	$ 0.354	$ 0.504	4.16	$ 0.09
ReadyMix_4-2	SU-6 6-axle ready mix truck with 2 pusher axles and 1 booster axle - 69,000 lbs state exemption	$ 0.13	$ 0.058	$ 0.188	1.55	$ 0.13	$ 0.399	$ 0.529	4.37	$ 0.09
ReadyMix_4-3	SU-6 6-axle ready mix truck with 2 pusher axles and 1 booster axle - 75,500 lbs	$ 0.13	$ 0.065	$ 0.195	1.61	$ 0.13	$ 0.485	$ 0.615	5.08	$ 0.09
ReadyMix_5-2	SU-7 7-axle ready mix truck with 2 pusher axle2 and 1 booster axle - 69,000 lbs state exemption	$ 0.11	$ 0.047	$ 0.157	1.29	$ 0.11	$ 0.329	$ 0.439	3.63	$ 0.09
ReadyMix_5-4	SU-7 7-axle ready mix truck with 3 pusher axles and 1 booster axle - 80,000 lbs	$ 0.12	$ 0.066	$ 0.186	1.53	$ 0.12	$ 0.523	$ 0.643	5.30	$ 0.09

* An effort has been made to meet legal axle or GVW limits - however, small tolerances were accepted within the weight tolerance allowed based on DPS roadside weighing procedures and agriculture axle weight tolerances.

** Compared with the total consumption rate for ReadyMix_1-1.

*** Top 20 counties of registered Ready Mix trucks are Dallas, Harris, Bexar, Tarrant, Collin, Comal, Travis, Fort Bend, Liberty, Mclennan, Montgomery, Brown, El Paso, Denton, Hidalgo, Williamson, Lubbock, Potter, Ector, and Hays. The consumption rates are calculated as the weighted average based on vehicle miles traveled (VMT).

3.2 Load Xpert Analysis of the Preliminary Set of Truck Configurations

Load Xpert is a truck modeling and load analysis calculation software that allows users to create diagrams and visually configure most types of trucks. Users can visually create truck models, upon which different types of loads can be placed, to analyze the load distribution and center of gravity of the loaded truck. The software also allows for easy modifications to truck load placement. With a click of a button, loads can be added or removed, and the software displays changes in axle loads instantly. Users are allowed to adjust not only loads, but the truck dimensions as well. The fifth wheel, axle groups and accessories on the truck can all be changed, depending on the real life truck being modeled. All of this data can be stored in configuration files which can be shared for collaboration. The software itself allows for the storage of size and weight information of tractors, trailers, accessories, payloads, axle groups, etc. in a database.

Truck configuration and load combinations can also be compared with the Federal Bridge Formula to make instant assessments of compliance. If the configuration is non-compliant, the software mentions which axle group is causing non-compliance, and by how much weight. Furthermore, the output of the Load Xpert analysis – the axle load distributions for the vehicle – can easily be transferred to pavement and bridge consumption analyses.

<u>How it was used in the analysis?</u>

In preparation of the truck configuration library, the team used Load Xpert to analyze a group of:

- Observed truck configurations and load combinations
- Hypothetical truck configurations and load combinations of possible cases in the coming legislative session based on discussions with TxDOT SME and industry

Observed truck configurations: a variety of current available truck configurations were analyzed for better understanding on how truck weights are currently distributed over axle groups, and assumptions or limitations when changes are made.

Hypothetical truck configurations: Inputs for possible legislation changes were taken from past legislative sessions and conversations with TxDOT SME and trucking industry representatives. Then, specific possible future configurations were modelled with the software and load distribution were calculated. The analysis also tested whether or which axle group(s) challenge the current weight limit or violate the Federal Bridge Formula B.

To begin the modelling of a truck configuration in Load Xpert, pre-existing templates for truck configurations can be selected, or new configurations can be created from scratch. Key inputs include:

- Type of axle (single, tandem, triple, liftable, etc.)
- Number of axles

- Axle group spacing
- Spacing between Axles and axle groups
- Tare weight of axles
- Positioning of axles
- Cab Type
- Positioning of fifth wheel and trailer kingpin
- Payload type (point, distributed (liquid, etc.))
- Positioning of load
- Type of tractor and trailer or straight truck (conventional, cab over etc.)

With all these inputs, an axle load distribution is created and shown. The result gives detailed information on:

- Weight on each axle group (tare + payload)
- Total weight on vehicle
- Top + Side view of vehicle with spacing dimensions
- Federal Bridge Formula compliance

Example Analysis

For the example of a Ready Mix Truck with a booster axle, once the data inputs for axle spacing, ready mix weight, etc. are put into the software, the model results are as follows:

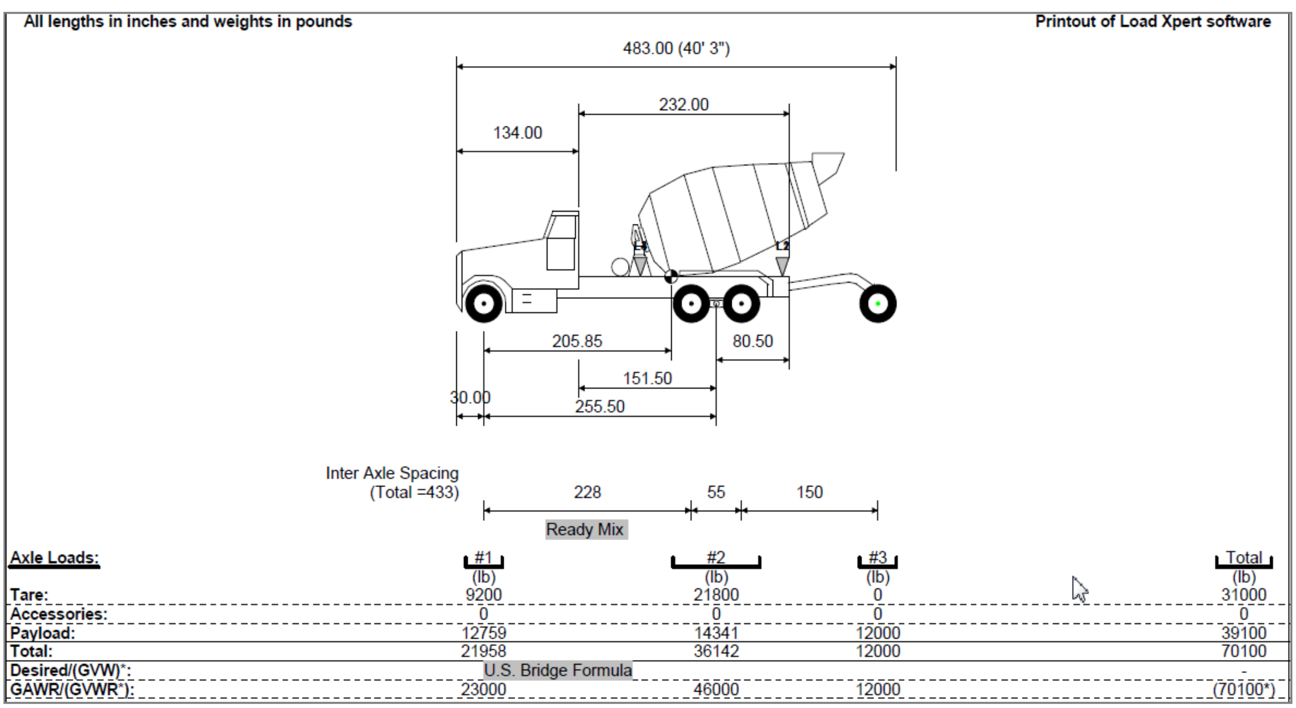


Figure 3.2: Dimension View of an example ready mix truck

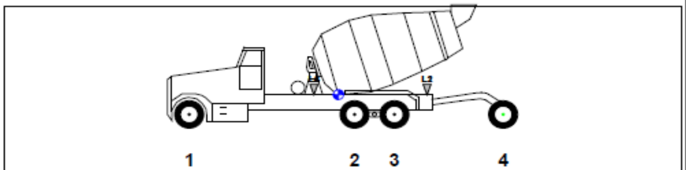
The results show, for example, that the final total axle spacing after adjustments were made to attempt compliance is 433” from the front axle to the rear liftable axle. The spacings are shown in the diagram of the truck configuration, while the table below shows the axle weight distributions. For example, the total weight on the steer axle is approximately 21,960 lbs, of which payload weight is approximately 12,760 lbs.

The second portion of results are those which assess the configuration based on compliance with the Federal Bridge Formula.

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	21958	◀												
2	20000	18071													
3	20000	18071													
4	20000	12000													
1 - 2	40000	40029	◀												
1 - 3	54000	58100	◀												
1 - 4	66000	70100	◀												
2 - 3	34000	36142	◀												
2 - 4	48500	48142													
3 - 4	40000	30071													

◀ = U.S. Bridge Formula Violation

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Figure 3.3: U.S. Bridge Formula check of an example ready mix truck

The results show axle numbers, how much weight the axles are allowed under the limits set by the Federal Bridge Formula, and how much weight the axles experience in the configuration that is being modelled. In each instance of a violation, the table shows a black left-pointing triangle. In this example, the model is non-compliant with the bridge formula in five separate occasions: the steer axle, the group of axles formed by axles 1 and 2, and so on.

This information is then provided to the pavement and bridge consumption analysis team and helps ensure that truck axle weights are consistent with the truck type and axle spacings. This is considered more consistent that simply assuming an axle weight distribution based on maximum legal axle weights.

More detailed results of the Load Xpert Analysis are discussed in Appendices D - F.

Chapter 4 Pavement Consumption Analysis

4.1 Background

During the Rider 36 study (Prozzi et al 2012), CTR evaluated Oversize/Overweight (OS/OW) load permits issued by the Motor Carrier Division (MCD) of the Department of Motor Vehicles (DMV). A pavement consumption analysis methodology was developed during Rider 36 considering that these loads might exceed either the Texas legal axle load limits or total gross vehicle weight (GVW). The Rider 36 pavement consumption methodology was used as a basis to evaluate heavy truck pavement consumption rates.This report presents a methodology for establishing equivalencies between OW loads based on the concept of *"equivalent consumption"* to the pavement structure using mechanistic-empirical pavement analysis procedures. In the proposed methodology, each pavement section is evaluated using three different distress criteria: (1) surface deformation or rutting, (2) load-associated fatigue cracking, and (3) riding quality in terms of roughness (International Roughness Index, IRI). The methodology proposed here represents a significant enhancement over previous procedures in the sense that it allows the analyst to adopt a modular approach towards calculation of the overall load equivalency for any given truck configuration because the overall pavement consumption due to a combination of different axles is equivalent to the sum of the consumption caused by each individual axle. The primary objectives of the pavement analysis are:

- Determination of the "equivalent consumption factor" (ECF) for different axle loads and axle configurations with respect to three different failure mechanisms: rutting, fatigue cracking, and roughness.
- Generalization of the results of the analyses using appropriate statistical techniques.

Equivalent Consumption Factor (ECF)

The fundamental principle behind the proposed methodology involves the assumption of equivalency between different axle loads and configurations that result in the same level of pavement distress, pavement performance or pavement consumption. In establishing such equivalency, a standard 18-kip single axle was used as the reference. Recent studies have also shown that the equivalency factors for different axle loads and configurations are partially governed by the bearing capacity of the pavement structure and the environmental conditions (Prozzi and De Beer 1997; Prozzi et all, 2007). It is, therefore, it is essential to determine ECFs for different axle loads over a spectrum of pavement structures.

In Texas, pavements are designed to reach a terminal distress condition under the given traffic and environmental conditions at the end of its design period, which is 20 years. However, due to inherent differences in the failure mechanisms, it is impossible to reach each of the three terminal distress values simultaneously at the end of the design period. Therefore, it becomes necessary to determine the required traffic volume that would result in the associated terminal distress under each of the failure criteria. Thus, the calculated traffic volume will depend on the distress mechanism being considered. Once the design traffic volumes are determined, the next step involves analyzing each of the pavement structures for a range of different axle loads and configurations and to determine the time (or traffic) to reach each of the aforementioned failure criteria. The Equivalent Consumption Factor (ECF) in this study is calculated as follows:

$$ECF = \frac{T_{18}}{T_L} \tag{4. 1}$$

Where

T_{18}: time to failure under "N" repetitions of a standard 18 kip axle; and
T_L: time to failure under "N" repetitions of any given axle load "L"

Therefore, the ECF represents the relative pavement life for any given pavement structure under given environmental conditions under the 18-kip single standard axle over the life of the same pavement under the same conditions under any given load and configuration. It is important to note that in this process, one would develop separate ECFs based on each of the distress criteria above-mentioned. From a practical standpoint, a given axle configuration loaded to "L" kips should have a single ECF. For these reason, it is important to establish a weighting mechanism to be applied to the individual ECFs (i.e. rutting, cracking and roughness) for establishing the combined and unique ECF for the particular axle load and configuration. The weighting mechanism should be devised such that it takes into account fundamental engineering principles. For example, it is known that rutting is more critical in warm climatic regions while cracking is the dominant distress mechanism in colder climatic regions.

Mechanistic-Empirical Pavement Analysis

For the mechanistic analysis, it was decided to use the newly developed AASHTOWare ME Pavement Design for analysis and computation of pavement distresses resulting from the imposed traffic (ARA, 2008). The AASHTOWare uses the same mechanistic-empirical concepts as its predecessor, the Mechanistic-Empirical Pavement Design Guide (MEPDG) developed under the National Cooperative Highway Research Program (NCHRP). The methodology has been approved by the American Association of State Highway and Transportation Officials (AASHTO) and supported by the Federal Highway Administration (FHWA).

In mechanistic-empirical pavement analysis, the fundamental pavement responses under repeated traffic loadings are calculated using a multi-layer linear elastic approach. This approach assumes that a flexible pavement is a multi-layered structure and that each of the layers exhibit a linearly elastic response to traffic loads. Although this is not the case, the linearity assumption is reasonable at the low strain levels typical of highway traffic. The method computes the stresses and strains that are induced in the pavement layers due to traffic loadings. These critical pavement responses are then related to field distresses using empirical relationships, which are calibrated based on field observations.

Experimental Design

The ECF for any given axle load and configuration is expected to be a function of the structural capacity of the highway facility (Prozzi et al, 2007; Kinder, 1988). Besides, environmental conditions determine several site features including the climatic profile and type of subgrade support which in turn have a bearing on the pavement response and performance that is typically built in a given region. For these reasons, it is important to design an experiment that encompasses different pavement structures, traffic levels and climatic regions.

Permitted load configurations do not necessarily conform to typical legal limits that are placed on highway vehicles. Due to the nature of the payload, these vehicles can have atypical axle configuration as well as axle loads. This aspect led the study team to simulate a wide range of axle loads with different configuration such that the full axle spectra for OW loads can be characterized. Contact stress (assumed to be equal to the tire inflation pressure) was restricted to 120 psi for all possible combinations of axle loads and configurations.

4.2 Analysis Results

Determination of ECF for Rutting

It is possible to establish an approximated linear relationship between the ECF and the normalized axle load on a log-log scale. As an example, Figure 4.1 shows that there is a strong linear relationship between these two variables.

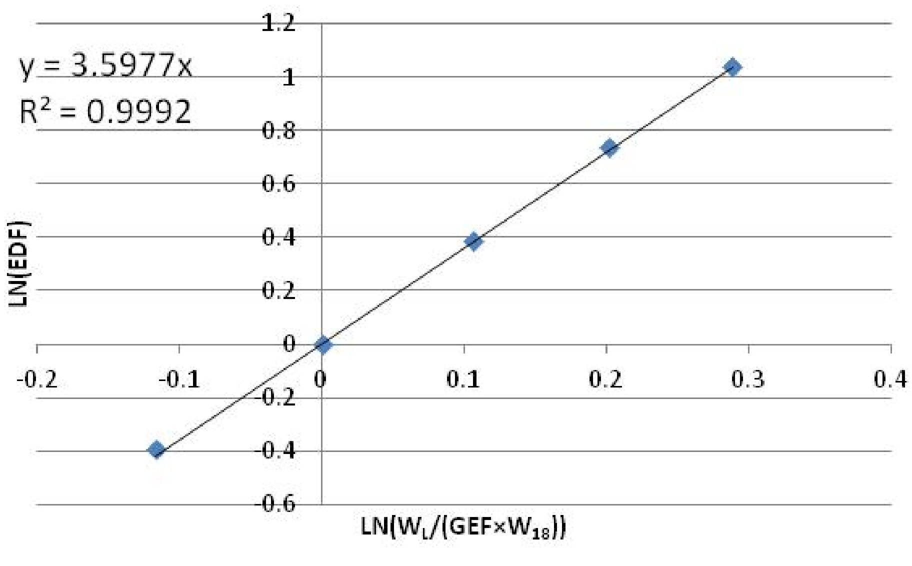


Figure 4.1: EDFs based on Rutting Criterion

The slope of the line differs slightly for all pavement sections and this indicates that the ECF for any given axle load and configurations is influenced by the pavement material properties, structural capacity of the highway and the environmental conditions. For the case of tandem and tridem axles, the study team introduced the group equivalency factor (GEF) in establishing the ECF. The following generalized expression was used to estimate the ECF for any given axle load and configuration while using the rutting failure criteria:

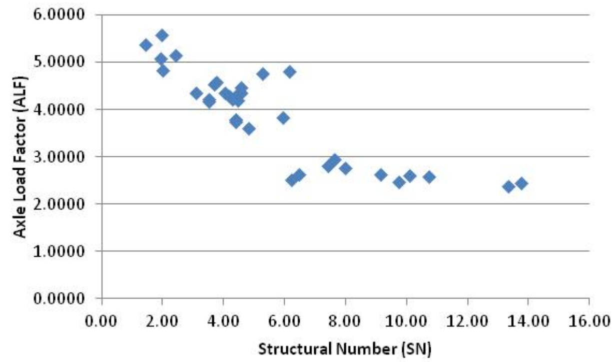
$$ln(ECF) = \alpha \times ln\left(\frac{T_{18}}{T_L}\right) = \alpha \times ln\left(\frac{W_L}{\beta \times W_{18}}\right) \tag{4.2}$$

Where

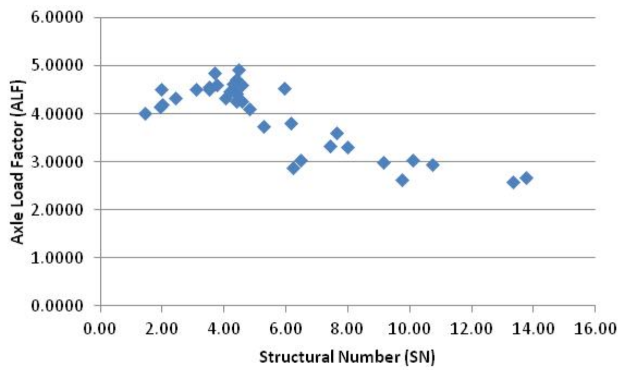
α	=	Axle Load Factor (ALF)
β	=	Group Equivalency Factor (GEF)

It was established that the axle load factor (ALF) is quite consistent for a given pavement structure and hardly changes for the different axle groups. Based on the literature, ALFs are expected to be a function of the structural capacity of the pavement structures. This would imply that the ALF should exhibit high correlation with the structural number, as the GEF is optimized, such that it gives the best linear predictor between the ECF and the normalized load in a log-log scale for all pavement sections included in this study.

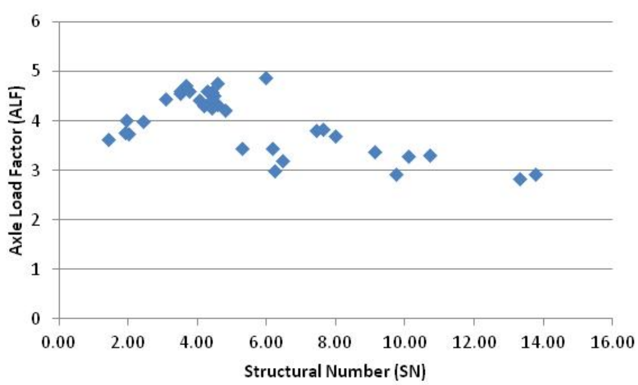
Figure represents the correlation between Axle Load Factors and pavement structural capacity as represented by its structural number (SN). It is between axles.



(a) Single



(b) Tandem

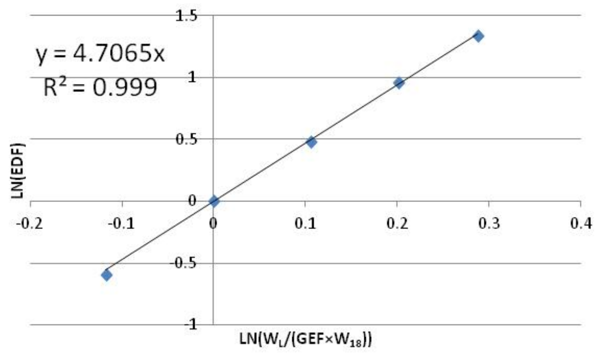


(c) Tridem

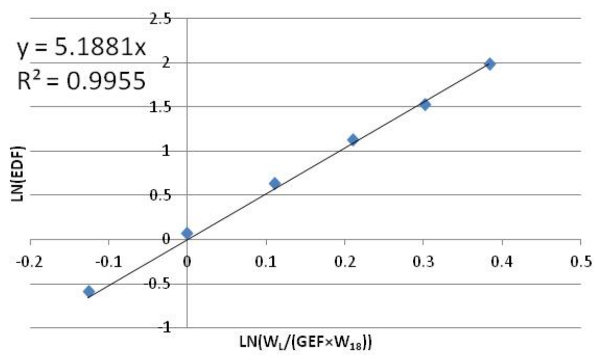
Figure 4.2: Relation between ALF and SN based on Rutting

Determination of ECF for Fatigue Cracking

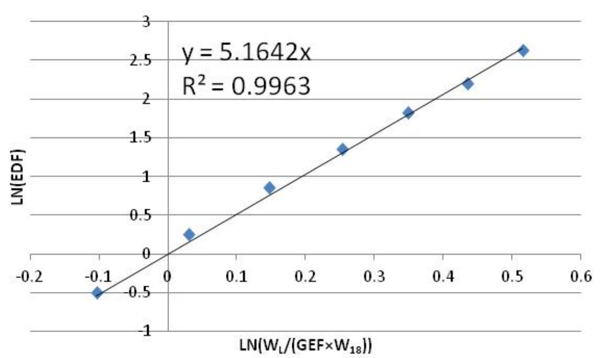
The calculation of ECF for fatigue cracking was undertaken using the same approach as for rutting. As an example, Figure shows the relationship between the normalized loads and the ECF on a log-log scale.



(a) Single Axles



(a) Single Axles



(a) Single Axles

Figure 4.3: ECFs based on Fatigue Criterion

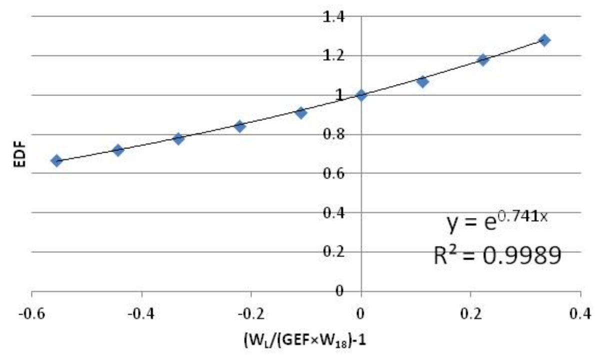
Once again, it was observed that the calculated ALF follow a similar pattern for different axle configurations for different pavement sections. It is important to note that the rutting and fatigue cracking transfer functions, which are used in the mechanistic analysis, have similar specification forms which explains why the relationship between these two variables has similar characteristics. However, it was noticed that the ALF values when computed using the fatigue cracking failure criterion are numerically higher than those calculated using the rutting criterion.

While for the rutting failure mechanism, a noticeable relationship between ALF and SN was observed across different axle configurations, the situation was not the same in the case of the fatigue cracking. Due to the lack of a significant correlation in this case, the study team decided to compute an average for each of the axle configurations included in this study.

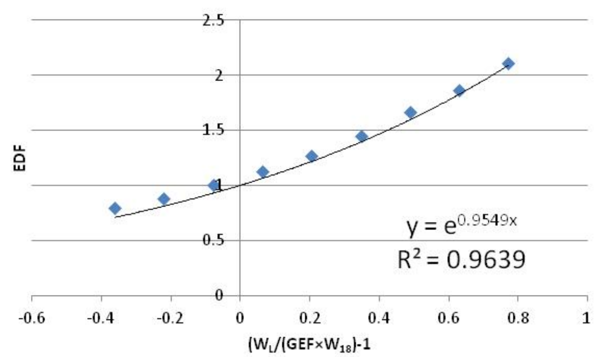
It is interesting to note that there is a noticeable trend in the mean of the ALFs for the different axle groups. In general, the ALF decreases with increasing number of axles per axle group.

Determination of ECF for Roughness

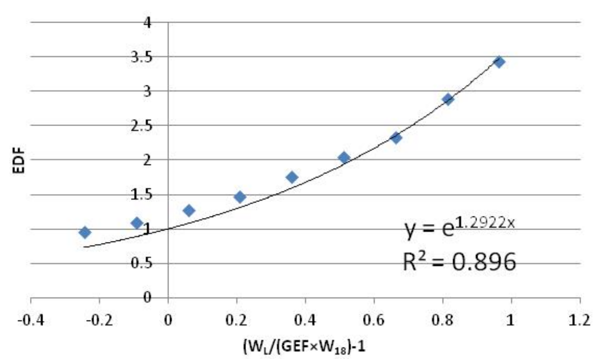
The determination of the ECF based on roughness was approached differently than that for rutting or fatigue cracking. The initial estimates for the ECF were calculated using Equation 4.1 where the time to failure for a given axle load and configuration were normalized using the time it took for the pavement to fail under the standard 18-kip single axle. Riding quality deteriorates and roughness increases as a result of the increase of one or more of the primary distresses including rutting, shoving, fatigue or thermal cracking. AASHTOWare uses a transfer function that relates predicted roughness values with other forms of distresses using a linear model. Consequently, the EDFs calculated did not follow a power relationship. After careful investigation of the trends in the data, it was realized that the relationship between the normalized load and the EDF can be approximated by an exponential relationship. Figure presents the ECFs calculated for single, tandem, tridem and quad axles for two different sections based on the roughness analysis.



(a) Section 1, single axle



(b) Section 1, tandem axle



(c) Section 1, tridem axle

Figure 4.4: EDFs based on Roughness Criterion

Following is the relationship that was used to relate the EDFs calculated using the roughness failure criteria with the normalized load:

$$\ln(ECF) = ALF \times \left(\frac{W_L}{GEF \times W_{18}} - 1\right) \tag{4.3}$$

While in the case of rutting and fatigue cracking, it was seen that there is a strong linear relationship between the GEFs and the number of axles in the axle group, the same was not the case for those calculated using the roughness criteria. In fact, it was noticed that a power law can relate the GEF to the number of axles in the group (see Figure).

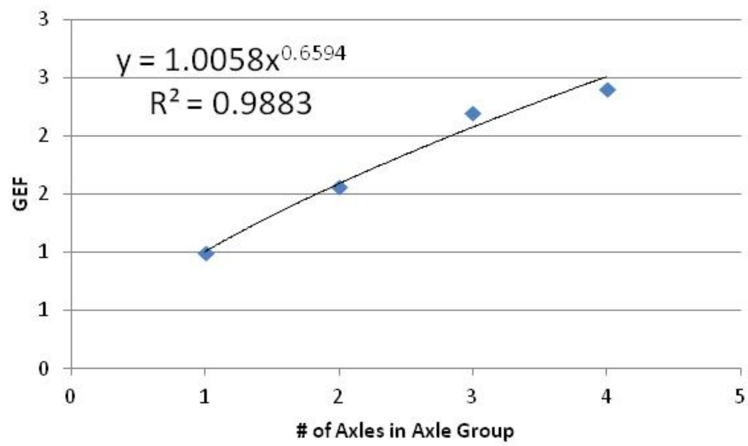


Figure 4.5: Relationship between GEF and Number of Axles

When evaluating the correlation between ALFs with the bearing capacity of the highways in terms of SN, no systematic trends were found. For this reason, an ALF with $\rho = 0.7$ is proposed for single axles and with $\rho = 0.9$ for the other axle groups. The final relationship for determination of EDF using the roughness is as given below:

$$\ln(ECF) = \rho \times \left(\frac{W_L}{GEF \times W_{18}} - 1\right) \tag{4.4}$$

Chapter 5 Bridge Consumption Analysis

5.1 Analysis Objective and Results Description

The objective of this analysis is to provide an estimate of the bridge consumption costs for designated truck configurations, by county, urban/rural area, and highway classification. One of the configurations is the standard 18-wheeler (interstate semi-trailer at 80K gross vehicle weight), which provides a baseline case for incremental cost calculations. The estimated costs are per one-way trip and per mile.

Urban/rural information comes from RHiNo 2013, data item "functional system." The highway classifications had to be grouped in similar classes, in order to ensure a representative number of bridges in each county, urban/rural area, and highway class. Table 5.1 shows the aggregated classifications used in this analysis.

Table 5.1: Highway Classes Used in the Bridge Analysis

Bridge Analysis Route Designations	Comprises	
	Description	*RHiNo 2013 Route Designations*
FM/RM/PR	FM-RM-RR-PR-Rec. Roads and their spurs	FM, FS, PR, RE, RM, RR, RS
IH	IH main lanes and frontage road segments with bridges	IH
SH	State highways	SH
SL/SS/BR/OSA	State loops, State spurs, their business roads, and all on-system arterials	BF, BI, BS, BU, PA, SL, SS
US	US highways, alternatives, and spurs	US,UP,UA

Note: Table 5.3 provides more information on the abbreviations used in Table 5.1.

The cost of any specific one-way route can be estimated by multiplying the unit cost by the route mileage, taking care to match highway class, and urban/rural area. For round trip, double the cost. If a route contains a segment with multiple highway classifications, the highest classification should be utilized. If a new road with a previously non-existent classification is being considered, use the estimates by urban area and region (east or west Texas) for that highway class. When estimating a route cost, is important to assign each route segment to its proper urban or rural area. The average costs generally are considerably different due to the higher bridge density in urban areas.

Cost of one trip over the mileage.

Centerline mileage of all roads included in the classification, by county and area.

Average number of bridges/mile in the road mileage described above.

Estimated cost of an one-way, one-mile-long trip on a road included in classification, located in (rural/urban) area of the county.

County	UR	Classification	cost	mileage	Density	Cost/mi/trip
ANDERSON	RURAL	FM/RM/PR	$ 1.22	249.744	0.7888	$ 0.00
ANDERSON	RURAL	SH	$ 0.73	68.484	2.2487	$ 0.01
ANDERSON	RURAL	US	$ 3.53	80.59	1.824	$ 0.04
ANDERSON	URBAN	SL/SS/BR/OSA	$ 1.07	12.13	2.9678	$ 0.09
ANDERSON	URBAN	US	$ 0.05	17.162	4.7197	$ 0.00
ANDREWS	RURAL	SH	$ 0.12	108.08	0.3238	$ 0.00
ANGELINA	RURAL	FM/RM/PR	$ 0.96	182.979	1.093	$ 0.01
ANGELINA	RURAL	SH	$ 1.65	61.8	1.9417	$ 0.03
ANGELINA	RURAL	US	$ 2.18	52.63	2.1471	$ 0.04
ANGELINA	URBAN	FM/RM/PR	$ 0.48	24.012	4.6227	$ 0.02
ANGELINA	URBAN	SL/SS/BR/OSA	$ 3.89	20.715	6.2756	$ 0.19
ANGELINA	URBAN	US	$ 5.69	16.875	7.1111	$ 0.34
ARANSAS	RURAL	FM/RM/PR	$ 0.01	18.312	1.7475	$ 0.00
ARANSAS	RURAL	SH	$ 3.62	33.27	1.0219	$ 0.11
ARANSAS	URBAN	SH	$ 0.28	5.04	3.5714	$ 0.05

Figure 5.1: Sample of the bridge analysis results for one truck configuration

5.2 Bridge Consumption Methodology

The data available in the NBI/BRINSAP database is conducive to the application of simplified methodologies to estimate bridge consumption for load configurations at the policy level. Applying Equation 5.1 twice (once for the Inventory rating load and again for the heavy weight truck load) and then subtracting one result from the other, one obtains Equation 5.2.

$$\log N = C - m \log S \tag{5.1}$$

Where:

- N – Number of cycles or load applications
- S – Stress range
- m – Constant: material dependent
- C – Constant

$$\frac{N_{Inventory}}{N_{OSOW}} = \frac{S^m_{OSOW}}{S^m_{Inventory}} \tag{5.2}$$

Where:

$N_{inventory}$ – Number of load applications for the inventory rating load
N_{OSOW} – Number of load applications for the OS/OW load
$S_{inventory}$ – Stress range for the inventory load
S_{OSOW} – Stress range for the OS/OW load
m – Constant: material dependent

At the policy level, it is not feasible to calculate actual stress ranges for bridge details. Digital descriptions of bridge cross sections and other characteristics are not available; even if they were, computational demands would make this task unfeasible within this project's time frame. An acceptable method successfully used in previous OS/OW studies involves using live load bending moments as surrogates for the stress range (Imbsen et al., 1987; Weissmann & Harrison, 1992; and Weissmann, et al., 2002). This approach substitutes the stress ranges in Equation 5.2 with bending moments, defining the bridge consumption ratio as depicted in Equation 5.3. Simply put, Equation 5.3 states that the bridge consumption ratio induced by a bending moment of an inventory rating load passage on a given bridge is equal to 1. Loads inducing bending moments twice as large as the inventory rating bending moment lead to a bridge consumption ratio of two to the power "*m*", where "*m*" is a function of the bridge material. Altry et al., 2003 and Overman et al., 1984, recommend "*m*" values that can be matched to the corresponding BRINSAP structure type codes.

$$ConsumptionRatio = \left(\frac{M_{OSOW}}{M_{Inventory}} \right)^m \tag{5.3}$$

Where:

$M_{inventory}$ – Live load bending moment for the inventory rating load
M_{OSOW} – Live load bending moment for the OS/OW load
m – Constant: material dependent

The bridge consumption in dollars due to the passage of a given load is estimated by using Equation 5.3 combined with a consumable asset value for the bridge. The recently completed Federal Truck Size and Weight study recommends that the current asset value of a bridge is $235 per square foot of deck area. Previous highway cost allocation studies established that the asset value of a bridge should be allocated according to **Error! Reference source not found.**, with 11 percent of the bridge asset value attributable to loads that are over HS20-44 (FHWA, 2000). HS20-44 is a standardized bridge design load, and current bridge inventory ratings are usually represented as multiples of the HS20 design load when recorded in NBI/BRINSAP.

Table 5.2: Bridge Asset Value Percentages for GVW Categories

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%**

With the help of computerized routines, Equation 5.4 is applied on a bridge-by-bridge basis to all bridges in each county, urban/rural area, and highway classification used in this analysis. Bridge asset consumption results for each bridge are summarized and aggregated to determine an overall cost for a given mileage of a given highway class in a given area of a given county. This is divided by the mileage to get a cost-per-mile for bridge consumption.

$$Consumption_{osow} = [(Area)(235)(0.11)\left(\frac{M_{OSOW}}{M_{Inventory}}\right)^{m}] \div (2{,}000{,}000) \quad (5.4)$$

Where:

$M_{inventory}$ – Live load bending moment for the inventory rating load for each bridge in the permit dataset
M_{OSOW} – Live load bending moment for the OS/OW load for each bridge in the permit dataset

m – Constant: material dependent
235 – Asset value for a bridge in dollars per bridge deck square foot
0.11 – The bridge asset value responsibility for heavy trucks (see Table 5.3).
2,000,000 – Number of allowable load cycles that define bridge design life according to AASHTO.

The computer program Moment Analysis of Structures (MOANSTR) is used to calculate the live load moment ratios required by Equation 5.4. The MOANSTR program's core is a finite differences routine that calculates live load moment envelopes generated by SLA truck configurations and NBI/BRINSAP rating loads. The MOANSTR routine, developed by members of the UTSA research team, incorporates previous research by Matlock (Matlock et al., 1968) and others (Weissmann & Harrison, 1992 and Weismann et al., 2002). MOANSTR calculates moment envelopes and identifies the maximum live load bending moments (positive and negative) induced by the SLA truck configuration and the inventory rating load.

5.3 Data Preparation

The steps listed below summarize the data preparation that was necessary to obtain mileages, assign a consistent highway classification as well as urban/rural area to each bridge, and arrive at the cost results previously discussed.

Step 1: Assign a consistent urban/rural classification to each bridge.

First, urban/rural classifications were retrieved from both RHiNo and BRINSAP, using their functional system variables. Urban/rural classification using the "functional system" RHiNo variable does always not match the urban/rural classification using BRINSAP's equivalent variable, described in item 26/26A of the coding guide. It was necessary to manually resolve all inconsistencies.

Step 2: Develop a highway classification system that is consistent with RHiNo and BRINSAP.

The research team needed to assign a RHiNo classification to each bridge. As depicted in Table 3, highway classifications in RHiNo do not always match those used in BRINSAP (items 5.2 or 5.2A, depending on whether the bridge is located on the inventory route or passes under it). Every time the two classifications did not match, the bridge was assigned the same classification as the RHiNo segment where each it is located.

Once each bridge had a RHiNo classification, the following was done:

1. Using RHiNo, determine the total centerline mileage within each county and urban/rural area for each highway classification.

2. Using BRINSAP and the RHiNo highway classification of each bridge, determine the number of bridges in each county, urban/rural area, and each RHiNo highway classification.
3. Not every area in each county actually had bridges in each RHiNo classification; thus, it was necessary to aggregate some classifications to ensure meaningful results. These final aggregated classifications were listed in Table 5.3.

Table 5.3: RHiNo and BRINSAP On-System Highway Classifications

RHiNo Variable Value	RHiNo Highway Route Designation	BRINSAP Variable Value	BRINSAP Variable Description	Closest Route Designation to RHiNo's
BF	Business FM	28	Business F.M. Hwy	BF
BI	Business IH	25	Business Interstate	BI
BS	Business SH	27	Business S.H. Hwy	BS
BU	Business US	26	Business U.S. Hwy	BU
FM	FM	15	Farm or Ranch to Market Road	FM/RM
FS	FM Spur			
IH	IH	11	Interstate Highway	IH
PA	Principal Arterial			
PR	Park Road	16	Park Road	PR
RE	Recreational Road	17	Recreational Road/Spur	RE
RM	RM	15	Farm or Ranch to Market Road	FM/RM
RR	Ranch Road			
RS	RM Spur			
SH	SH	13	State Highway	SH
SL	SL	14	State Loop or Spur	SL/SS
SS	State Spur	14	State Loop or Spur	SL/SS
UA	US Alt.			
UP	US Spur	12	US Highway (Spur)	US (Spur)
US	US	12	US Highway (Spur)	US (Spur)
		20	Toll Road	
		51	State Lands Road	
		19/99	Other	
		24	NASA1	
		41	Federal Lands Rd	

Step 3: ***Identify and eliminate from the analysis parallel bridges, culverts, and tunnels.***

BRINSAP has variables identifying these situations. Culverts and tunnels are straightforward, and so is travel direction. However, an additional data treatment was necessary to eliminate parallel bridges in the same traffic direction, which are often present. BRINSAP item 101 was used but several cases had to be manually checked in online maps and pictures using the geographical coordinates of the bridge. The data treatment to eliminate all parallel bridges was necessary due to the nature of the RHiNo data reportong centerline mileage. If calculating the consumption due to one truck pass, considering more than one parallel bridge in the same location would artificially increase the cost; the truck consumes only one of the bridges in each pass.

Step 4: ***Calculate the bridge consumption of all on-system bridges.***

The previous steps resulted in an analysis database with all pertinent BRINSAP variables, the aggregated highway classification developed as described in step 2, an urban/rural area consistent with RHiNo, and no parallel structures or structures other than on-system bridges. This database was used to calculate the moment ratio and costs for each bridge, which were then added up by highway classification, area type, and county, to obtain the final results reported in the spreadsheets previously discussed (see **Error! Reference source not found.** and **Error! Reference source not found.**). The costs were also added up by highway classification, urban/rural, and Texas region (east/west) for use in planned or new highways with a classification that was previously nonexistent in the desired county.

5.4 Conclusions

The product of this analysis is a network-level bridge consumption cost per vehicle miles traveled by county, urban/rural area, and the aggregated highway class depicted in Table 5.1, for each of the configurations of interest. It provides a useful tool to estimate the bridge consumption costs of proposed configurations for any given route in any county. Nevertheless, such estimates are less accurate than a project-level analysis of specific routes or corridors, basically for two reasons:

1. A corridor or route analysis calculates each specific bridge consumption cost rather than use average costs by factorial cells, and

2. The network-level analysis presented here depends on averages by highway class, area, and county, which in turn required resolving some inconsistencies among RHiNo and BRINSAP based on network-level type of reasoning and/or judgment, as previously discussed. This does not occur in a route-specific analysis where each individual bridge is considered. On the other hand, this analysis is not tied up to specific routes or highways and its results can be used statewide.

Chapter 6 Workshop II and Discussion Results

Workshop II was held from 9:00 to 11:30 AM on July 18, 2016 at TxDOT D.C. Greer Building. Forty representatives from trucking industry associations, city and state agencies, TxDOT and CTR/UTSA attended this workshop. The sign-in sheet of this workshop is contained in Appendix G.

The main purpose of this workshop was to provide an opportunity for the CTR/UTSA research team to present preliminary pavement and bridge consumption analysis results for the truck configurations included in the Library. In addition, the study team sought feedback from the industry on the analysis to ensure that no important factors were missed.

When this workshop was held, twelve ocean container truck configurations, five milk tank truck configurations and seven ready mix truck configurations had been analyzed and added to the Library. The CTR/UTSA research team presented case studies based on the truck configuration Library which included a summary table of all the configurations that has been analyzed and detailed analysis results for each configuration. The CTR/UTSA research team explained the weight and dimensions of these configurations and how bridge and pavement consumption rates were calculated.

Dr. Jose Weissmann explained that bridge consumption rates are a function of bridge density, or bridges per mile. As a result, the bridge consumption rates for a metro county such as Harris County in Houston would be higher than bridge consumption rates for a rural county, such as Hudspeth County. These differences resulted in significant total pavement and bridge consumption costs considering statewide, metro, urban and rural counties and different route classifications. Thus, in general, an Interstate (IH) route in a rural county could be expected to have lower consumption costs that an Interstate route in a metro county. In addition, Dr. Weissmann explained that the number of bridges above their operating rating was calculated for each configuration since TxDOT had set a policy that a configuration which resulted in a load 50% above the operating rating would require that the bridge is load posted.

During the presentation, interesting questions are brought up and discussed among CTR/UTSA research team, industry representatives and TxDOT personnel. The presentation slides are attached as Appendix H.

An open discussion session was held after the presentation. The CTR/UTSA research team asked for input from the industry regarding additional truck operational types and configurations of interest to the audience. Questions regarding over weight milk tankers, livestock trailers, grain haulers and mobile cranes were discussed. CTR/UTSA requested more detailed specifics for these trucks to be submitted to TxDOT so that a determination could be made whether an analysis would be performed. Other major results from this discussion are:

- Each truck configuration is analyzed in terms of pavement consumption, bridge consumption and number of bridges that would require posting depending on bridge density, county and route designation (IH, US, SH and FM roads).
- The goal of the configuration analysis is to achieve distribution of the load among the axle groups to meet the federal bridge formula requirements and then to achieve the minimum possible consumption rates.
- The Truck Configuration Library provides information about the consumption rates of legally loaded trucks as the 'base line' and the consumption rates of the heavier trucks for calculation of a consumption ratio to the base line truck.
- Bridge consumption rates can be very different among different counties due to different bridge density or number of bridges per mile.
- More truck configurations will be studied to arrive at some general recommendations for lower $/VMT configurations with lower bridge posting issues.
- Oil Well Service Rigs do not need to be considered due to the high percentage of bridges that would require posting.
- Projecting the potential reductions in number of trucks after weight limit change or evaluating the benefit of truck industry bring to the state are out of the scope of this study.
- The CTR/UTSA research team advises or answer questions posed by the State Legislature or TxDOT Administration; the research team does not develop policy.

Detailed summary notes of the presentation given and discussion held during this workshop are contained in Appendix I. This workshop informed the industry regarding configurations that were analyzed to date and the CTR/UTSA research team's approach for performing consumption analysis. The Workshops helped to create an open line of conversation between TxDOT, researchers and industry. Many interesting questions were raised and discussed.

Chapter 7 Summary and Conclusions

A Truck Configuration Library was developed based on three truck operational types: Ready Mix Trucks, Milk Tank Trucks and ocean containers. The Truck Configuration Library includes information specified by TxDOT SLA including:

- Pavement, bridge and total consumption rates for each truck configuration
- A 'base case' truck representing the maximum, legal size and weight permitted in Texas. Other configurations were compared to the base case to determine a factor indicating equality (1.0) lower consumption (< 1.0) or higher consumption (> 1.0).
- The Truck Configuration Library contains a summary page listing all configurations that were analyzed grouped according to truck operational type. A hyperlink is provided for each configuration which directs the user to a detailed page for that specific configuration
- The detailed truck configuration page contains a photograph of a truck similar to the configuration analyzed, a Load Xpert analysis showing the truck dimensions and axle or axle group load distributions, the pavement and bridge consumption rates. Bridge consumption rates are provided for all 254 counties for each configuration. A network-level assessment of the number of bridges that are 50% above operating rating and are potential candidates for load posting.

During development of the Truck Configuration Library, two Workshops were conducted to obtain feedback from the trucking industry regarding:

- Options available to the truck driver to adjust truck axle and axle group loads
- Information about fixed design features, such as mixer drum front and rear pedestal load percentages
- Discussions regarding the difference between consumption rates, and in particular bridge consumption rates in a high bridge density metro county versus and low bridge density rural county.
- Differences in consumption rates for different route types (IH, US, SH, FM roads etc.)
- Discussions regarding other truck operational types of interest to industry and thus potential truck types for further analysis:
    - Livestock tractor – trailers
    - Livestock feed trucks
    - Higher weight limits for milk tank trucks
    - Mobile cranes
- However, no further analyses were performed beyond the three truck types mentioned above.

The Workshop presentations and summary notes are included as appendices to this report. The performing agency also attended project meetings and one-on-one meetings with the truck industry at the request of SLA.

Pavement and Bridge Consumption Conclusions

The main findings of the pavement and bridge consumption analysis are discussed in the following section:

Ready Mix trucks

- Based on Load Xpert analyses of 3-axle ready mix trucks, the maximum allowable load of 69,000 lbs GVW cannot be achieved unless an annual permit is purchased that allows for higher axle weight limits, and in particular, tandem drive axle weight limits, than is permissible by state statute.
- The SU-4 configuration whether with a booster or one pusher axle was not found to meet the Federal Bridge Formula (FBF) requirements at the proposed 70,100 lb GVW limit.
- The SU-5 through SU-7 ready-mix truck configurations comply with the FBF based on the allowable GVWs listed in the previous legislative session bill

Milk Tank Trucks

- A 6-axle 90,000 lb GVW milk tank truck with tridem axle trailer configuration results in a lower consumption rate than a milk tank truck with tridem tractor. This configuration meets federal axle group load requirements.
- Recent rulings contained in the FAST Act (Fixing America's Surface Transportation) provides an exemption for milk tank trucks that allows operation to the maximum tank capacity as a 'non divisible' load. Thus, a fully loaded milk tanker that exceeds 80,000 lbs can operate on the Interstate Highway system.
- The Dairy Industry representatives who attended the workshop expressed interest in proposing a higher GVW limit of 95,000 lbs or 97,000 lbs GVW though no further analysis of these higher limits was undertaken

Ocean Containers

- Container configurations operating in California and Washington State were evaluated based on discussions with the chief engineer with Dionbilt Trailers, a major west-coast chassis designer / manufacturer.
- Pavement and bridge consumption analyses were performed for 6-axle and 7-axle ocean containers at a maximum GVW of 97,000 lbs. The 7-axle configurations yielded lower consumption rates and the increase in consumption rates was lower with increased GVW above 97,000 lbs (up to 102,000 lbs)

- The resulting analysis showed that the consumption rates for heavy weight containers operating in Harris County are significantly higher than the same truck configuration and weight based on state wide consumption rates or rates in rural counties in Texas.
- Each configuration was analyzed with regard to bridge operating rating. It was found that certain configurations could exceed 50% of the operating rating for some bridges which suggests that bridge load posting might be required.

Analyses of Oil Well Servicing Units was not undertaken based on preliminary analyses that showed 50% to 100% of the state's bridges would be above operating rating for certain configurations proposed in draft legislation.

The Truck Configuration Library and the Final report are deliverables under this contract along with the two Workshops, project meetings and presentations that were prepared.

The performing agency looks forward to future opportunities to add to the Truck Configuration Library as new truck operational and configuration types are considered by the state legislature.

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Appendix A: Workshop I Attendees

Name	Organization Represented	Email Address
Tommy Engelke	Texas Agriculture Coop Council	tommy@texas.coop
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Shanna Igo	Texas Municipal League	sigo@tml.org
Rick Thompson	Texas Association of Counties	rickt@county.org
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James Terrell	Select Milk Producers	talltexan2@gmail.com
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Appendix B: Workshop I Presentation

THE UNIVERSITY OF TEXAS AT AUSTIN
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Oversize / Overweight Vehicle Workshop

TxDOT D.C. Greer Building
Hearing Room

February 29, 2016

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IAC Manager – Tonia Norman
Project Management Blake Calvert

UT –CTR Contract Supervisor – Professor C. Michael Walton, P.E.

Project Team Members

UT-CTR

Dr. Jorge Prozzi	Faculty - pavement modeling / consumption
Dr. Mike Murphy, P.E	Research Engineer / Configurations / Interviews / Factors
Mr. Robert Harrison	CTR Deputy Director - Economics / Cost analysis
Dr. Hui Wu, P.E.	Research Assistant Configurations / Factors / Safety considerations
Ms. Lisa Loftus-Otway	Legal / Legislative issues
Manar Hasan	MS GRA
Hongbin Xu	Ph.D. GRA
Swati Agarwal	MS GRA

UTSA

Dr. Jose Weissmann, P.E.	Faculty - Bridge analysis / modeling / consumption
Dr. Angela Weissmann	Researcher - Bridge analysis / modeling / consumption

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Dr. Mike Walton – Overview of on-going Truck Size & Weight studies

1. Origin of Texas – Pavement and Bridge Consumption Analysis Methods

Sunset Commission – TxDOT Review

Issue 7: Exemptions from oversize and overweight regulations cause considerable damage to roads and bridges.

More Information Is Needed to Improve Regulation of Oversize and Overweight Vehicles to Prevent Damage to Roads and Bridges

State Legislature: Rider 36 Conduct an analysis of OS/OW Vehicle Permit Fees

TxDOT Research Project: 0-6736 'Oversize/Overweight Vehicle Permit Fee Study'

http://ctr.utexas.edu/wp-content/uploads/pubs/0_6736_2.pdf **full-report**

http://library.ctr.utexas.edu/hostedPDFs/txdot/psr/0-6736-s.pdf **summary**

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Dr. Mike Walton – Overview of on-going Truck Size & Weight studies

2. State Legislative Affairs – Contract 'Develop a Library of Truck Configurations and Consumption Rates'

Task 1: Workshop I – identify truck configurations of interest to industry

Task 2: Work with TxDOT to identify truck configurations for draft Library

Task 3: Pavement Consumption analysis

Task 4: Bridge Consumption analysis

Task 5: Workshop II – present findings to Industry obtain Feedback

Task 6: Revise Library and add new Configurations as necessary: draft Library and Report

Task 7: Finalize Library of Configurations – Prepare final report

Project end date: October 31, 2016

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3. Project 0-6817 'Review and Evaluation of Current Gross Vehicle Weights and Axle Load Limits' Project Completion February 29, 2016

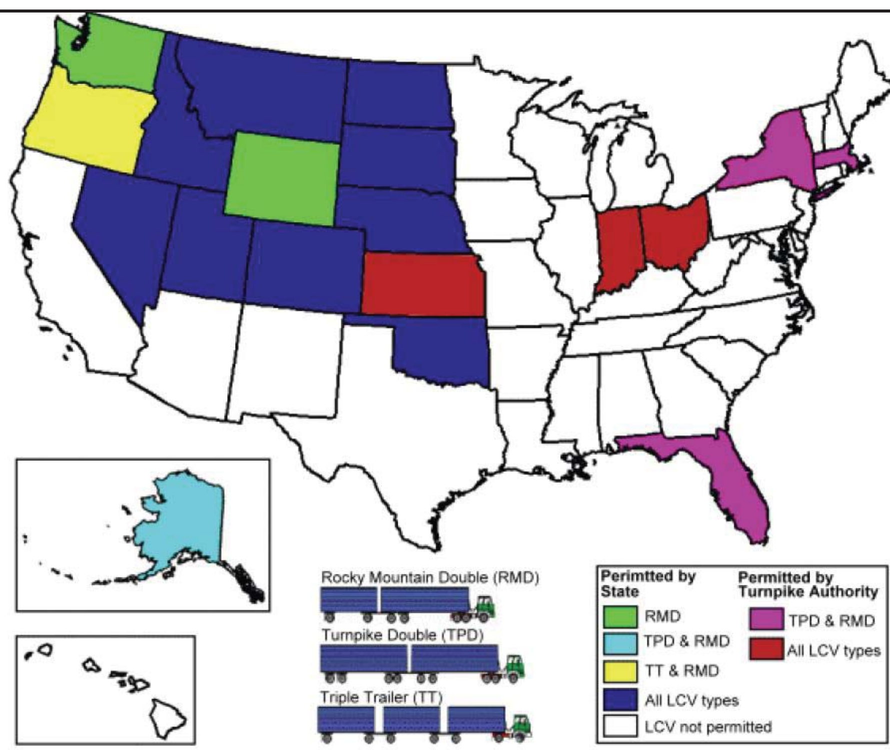
Extends the consumption analysis work originally done under Rider 36

Evaluation of 18 Infrastructure friendly truck configurations for Texas conditions

Configurations are implemented in other states or under consideration by USDOT/FHWA for national implementation (e.g. 33' double trailer unit)

Evaluation includes selected Longer Combination Vehicles (LCVs) operating in U.S. Western States, Canada and Mexico.

One or more LCV configuration are also permitted in every state from Canada to the Texas border with Oklahoma.



Source: U.S. Department of Energy, 2006

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Dr. Mike Walton – Overview of on-going Truck Size & Weight studies

4. Project 0-6820 'A Process for Designating and Managing OS/OW Corridors at Coastal Ports and Border Ports of Entry ' Project Completion August 31, 2016

5. Project 0-6897 'Evaluate Specialized Hauling Vehicles (in Texas) with regard pavement and bridge consumption and posting limits' Project Completion August 31, 2017

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1. Overview of Workshop Process — Dr. Mike Walton

2. Overview and Analysis

House Bill Truck Configurations — Dr. Mike Murphy
Pavement Consumption: — Dr. Jorge Prozzi
Bridge Consumption: — Dr. Jose Weissmann

3. Case Study: HB 3129 'Milk truck weight increase – 90,000 GVW'

4. Summary and Discussion — Dr. Mike Walton

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1. Overview of Workshop Process and Study Group Member introductions — Dr. Mike Walton

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1. **HB 3129 Raw milk tankers up to 90,000 lbs GVW**
2. **HB 3061 Sealed Ocean Containers 97,000 lbs GVW**
3. **HB 2606 New permit(s) for Oil Well Servicing Units**
4. HB 2592 Ready Mix Trucks up to 80,000 lbs GVW with associated axle configurations

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Current Legal maximum axle and gross vehicle weight – Configuration 1

Tandem axle group 34,000 lbs

Tandem axle group 34,000 lbs

Steering Axle 12,000 lbs

Gross Vehicle Weight = 80,000 lbs

Based on discussions with a dairy transport company, tank capacities 6,000 – 6,500 gallons

Raw milk is an agricultural product: state statutes allow:
5% over GVW and 12% axle weight tolerance – Configuration 2

Tandem axle group
36,000 lbs

Tandem axle group
36,000 lbs

Steering Axle
12,000 lbs

Gross Vehicle Weight = 84,000 lbs

Based on discussions with a dairy transport company, tank capacities
6,000 – 6,500 gallons

HB 3129 90,000 lb gross vehicle weight – Configuration 3

Tridem axle group
42,000 lbs
?

Tandem axle group
34,000 lbs

Steering Axle
14,000 lbs

Gross Vehicle Weight = 90,000 lbs

Based on initial calculations a 7,000 gallon milk tank trailer would be required.
Industry feedback is needed regarding axle configurations and tank sizes.

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1. HB 3129 Raw milk tankers up to 90,000 lbs GVW

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4. HB 2592 Ready Mix Trucks up to 80,000 lbs GVW with associated axle configurations

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Base Case

80,000 lb tractor semi trailer with ocean container (legal axle weights)

Steer axle
12,000 lbs

Drive tandem axle
34,000 lbs

Trailer tandem axle
34,000 lbs

Configuration 1

Assumes 17,000 lb tractor + 4,950 lb standard duty container trailer 58,050 lb container + cargo

97,000 lb tractor semi trailer with ocean container (HB 3061 axle weights)

t

Steer axle
12,000 lbs

Drive tandem axle
25,000 lbs

Trailer tandem axle
60,000 lbs
?

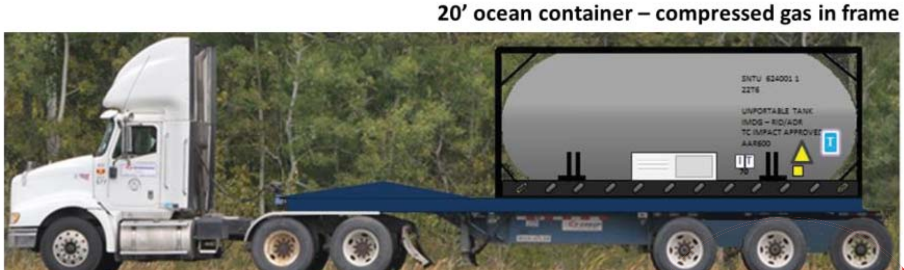
Configuration 2

Assumes 17,000 lb tractor + 11,400 lb heavy duty container trailer 68,600 lb container + cargo
Trailer length = 42' extended.

97,000 lb tractor semi trailer with ocean container (trailer tridem axle)

(on a 20' tridem axle container trailer, 32' collapsed position)

20' ocean container – compressed gas in frame



Steer axle
12,000 lbs

Drive tandem axle
25,000 lbs

Trailer tandem axle
60,000 lbs
?

Configuration 3

Assumes 15,000 lb tractor + 9,350 lb heavy duty container trailer 72,650 lb container + cargo

97,000 lb tractor semi trailer with ocean container (trailer tridem axle)

(20’ container on a 40’ tridem axle container trailer - 42’ extended position)

Steer axle
12,000 lbs

Drive tandem axle
35,000 lbs

Trailer tridem axle
50,000 lbs
?

Configuration 4

Assumes 15,000 lb tractor + 9,350 lb heavy duty container trailer 60,650 lb container + cargo
Trailer GVWR = 70,000 lbs

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1. **HB 3129 Raw milk tankers up to 90,000 lbs GVW**
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3. **HB 2606 New permit(s) for Oil Well Servicing Units**
4. HB 2592 Ready Mix Trucks up to 80,000 lbs GVW
with associated axle configurations

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SECTION 4. Chapter 622, Transportation Code, is amended by adding Subchapter K to read as follows:

SUBCHAPTER K. SPECIAL USE VEHICLES

Sec. 622.151. AXLE WEIGHT RESTRICTIONS. (a) In this section, "special use vehicle" means a self-propelled well-servicing unit.

(b) A special use vehicle may be operated on a public highway of this state only if:

(1) the quad axle weight is not heavier than 120,000 pounds;

(2) the triple axle weight is not heavier than 90,000 pounds;

(3) the tandem axle weight is not heavier than 65,000 pounds; and

(4) the single axle weight is not heavier than 30,000 pounds.

(c) A special use vehicle may be operated at a weight that exceeds the maximum single axle, tandem axle, triple axle, or quad axle weight limitation by not more than 10 percent if the gross weight is not heavier than 135,000 pounds and the department has

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HB 2606(S) 90,000 lbs GVW

Manufacturer's standard
Axle ratings
20,000 lb single
46,000 lb tandem
Standard Gross Vehicle Weight
66,000 lbs.

Single steer axle
HB 2606S 30,000 lbs

Tandem axle
HB 2606S 60,000 lbs

Configuration 1 (HB 2606 axle weights – as first introduced)

HB 2606   111,300 lbs GVW

Twin Steer axle
HB 2606S 55,650 lbs

Tandem Axle
HB 2606S 55,650 lbs

Configuration 4 (HB 2606 axle weights – as first introduced)

Manufacturers' estimated Gross Vehicle Weight = 82,000 lbs – 90,000 lbs: possibly greater

HB 2606 129,000 lbs GVW

Twin Steer axle
HB 2606S 60,000 lb

Tridem axle
HB 2606S 69,000 lbs

Configuration 5 (HB 2606 axle weights – as first introduced)

Manufacturers' estimated total weights vary from 91,000 lbs to 120,000 lbs: possibly greater

HB 2606 135,000 lbs GVW maximum cap

* Liftable axle paired with fixed tandem axle
axle spacing based on manufacturer's spec

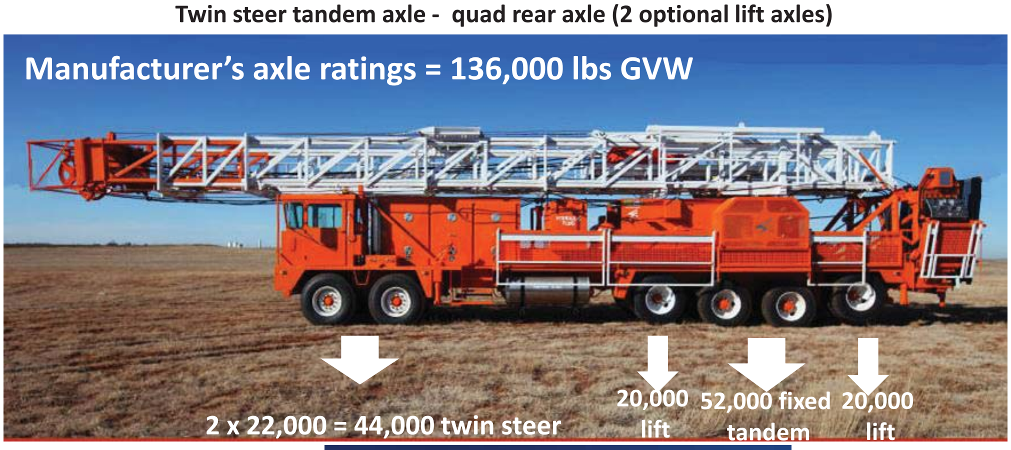
Tridem Steer Axle
HB 2606S 67,500 lb

Tridem Fixed Axle
HB 2606S allows 67,500 lbs

Manufacturers' estimated total weights vary from 97,000 lbs to 130,000 lbs: possibly greater.

Configuration 6 (HB 2606 axle weights – as first introduced)

Work over Rig
Twin steer tandem axle - quad rear axle (2 optional lift axles)



1. HB 3129 Raw milk tankers up to 90,000 lbs GVW
2. HB 3061 Sealed Ocean Containers 97,000 lbs GVW
3. HB 2606 New permit(s) for Oil Well Servicing Units
4. HB 2592 Ready Mix Trucks up to 80,000 lbs GVW with associated axle configurations

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TTC 622.011 - .017 Ready Mix concrete and pump trucks

Legal	Up to 20,000 lbs.	Up to 34,000 lbs.
Exemption	Up to 23,000 lbs.	Up to 46,000 lbs.

Legal: Total Vehicle up to 54,000 lbs. GVW

Exemption: Total Vehicle up to 69,000 lbs. GVW

* Cannot operate at over legal loads on IH or Defense Highway Network

HB 2592 'Ready mix trucks up to 80,000 lbs with additional axles'

HB 2592 **70,100 lbs** GVW if the Ready mix truck has 4 axles

HB 2592 **70,500 lbs** GVW if the Ready mix truck has 5 axles

HB 2592 **75,500 lbs** GVW if the
Ready mix truck has 6 axles

HB 2592 **80,000 lbs** GVW if the
Ready mix truck has 7 axles

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1. Overview of Workshop Process — Dr. Mike Walton

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Pavement Consumption: — Dr. Jorge Prozzi

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Equivalent Pavement Consumption Factors (ECF)

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(512) 471-4771

Texas Department of Transportation

Pavement Consumption Analysis

- Mechanistically-based methodology for the determining consumption due to "OW Traffic" relative to "Design Traffic".
- Outputs:
  - Developed methodology for determine relative pavement consumption.
  - Estimated consumption for typical axle and load configurations.
  - Estimated consumption for specific vehicles.

Texas Department of Transportation

Pavement Consumption Analysis

- From Load Equivalency Factor (LEF) to equivalent consumption factor (ECF)

- $LEF = \left(\frac{Single\ Axle\ Load}{18{,}000}\right)^4$

- $ECF = \left(\frac{Axle\ Load}{18{,}000.k}\right)^n$

Texas Department of Transportation

Pavement Consumption Analysis

- From Load Equivalency Factor (LEF)
  - Empirical (AASHO Road Test)
  - 1950's vehicles
- Equivalent Consumption Factor (ECF)
  - Mechanistically based
  - Nationally Calibrated
  - Multi-criteria
  - Today's Vehicles
  - Texas pavements and conditions

Texas Department of Transportation

Pavement Consumption Analysis

- Step 1: Traffic characterization and pavement design
  - Pavement design traffic (in ESALs)
  - Standard axle (18 kips single axle)
  - OW traffic
- We sampled 2,000 vehicles from OW Central Permitting System (CPS) database (now TxPROs)

Texas Department of Transportation

Pavement Consumption Analysis

- Step 2: Determination of traffic routing and representative pavement structures
  - Select representative traffic sample
  - Identify routes and quantify VMT
  - Select representative pavement structures
  - Develop pavement experimental design.

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Pavement Consumption Analysis

- Step 3: Mechanistic-Empirical Pavement Analyses
  - Axle configurations
    - Reference axle (18 kips single axle)
    - Other common axle configurations
  - Relative Pavement Consumption (RPC) =
    - Number of 18,000 lbs single axles to fail a pavement / number of other axle to fail same pavement

Texas Department of Transportation

Pavement Consumption Analysis

- Step 3: Mechanistic-Empirical Pavement Analyses (cont.)
  - Muti-criteria analysis:
    - Rutting
    - Cracking
    - Roughness
  - Distresses are a function of:
    - Pavement structure
    - Environmental conditions
    - Traffic (axle configuration and loads)

Texas Department of Transportation

Pavement Consumption Analysis

- Step 3: Mechanistic-Empirical Pavement Analyses (cont.)
  - Tool: AASHTO's DARWin-ME (Aug 2011)
  - AASHTO product supported by FHWA
  - ECF for individual axles using the following criteria @ 20 years:
    - 0.5" of rutting
    - 10% of lane area cracked
    - Terminal IRI = 125 in/mile

Texas Department of Transportation

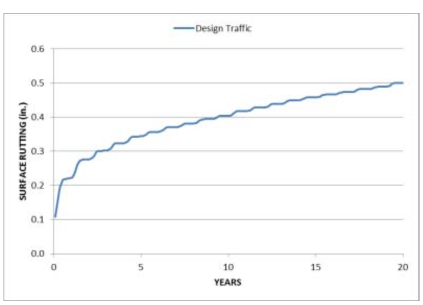
Pavement Consumption Analysis

- 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
  - Superimpose “Design + OW Traffic”
  - Determine the cost of additional pavement structure required to obtain equivalent performance as original design

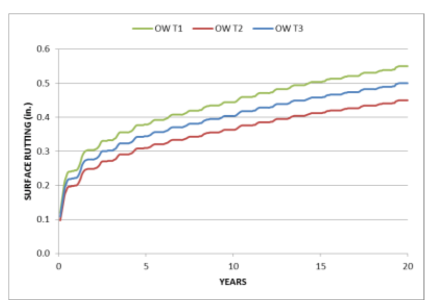
Pavement Consumption Analysis

- Step 4: Determination of OW Traffic to produce equivalent pavement consumption

Design Traffic

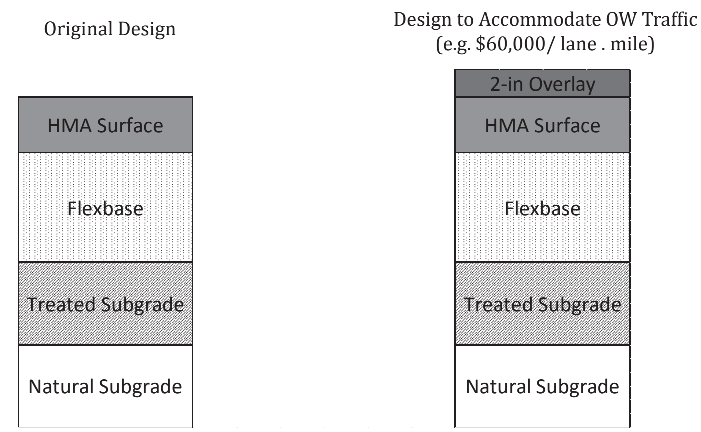


OW Traffic 1 = 300,000 vehicles
OW Traffic 2 = 200,000 vehicles
OW Traffic 3 = 240,000 vehicles



Pavement Consumption Analysis

- Step 4: Determination of OW Traffic to produce equivalent pavement consumption



Pavement Consumption Analysis

- At the end, we provided TxDOT with:
  - Step-by-step methodology that can be used to determine equivalent pavement consumption (ECF) for any vehicle configuration.
  - Estimated ECF for common axle configurations and facility types that can be combined to estimate consumption of specific vehicles on specific routes.
  - Average ECF for typical vehicles in Texas that can be used for planning and programming purposes.
- Based on marginal pavement consumption and marginal cost of reinforcing a new pavement.

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Bridge Consumption

Jose Weissmann and Angela Weissmann

University of Texas San Antonio
Department of Civil and Environmental Engineering

UTSA Engineering

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Data Sources

- Federally mandated bridge inventory (NBI/BRINSAP)
- Road segments GIS file
- Road Segments and bridge data combined with ArcMap
- Or County road mileage by road class
- Data cleaning using SAS

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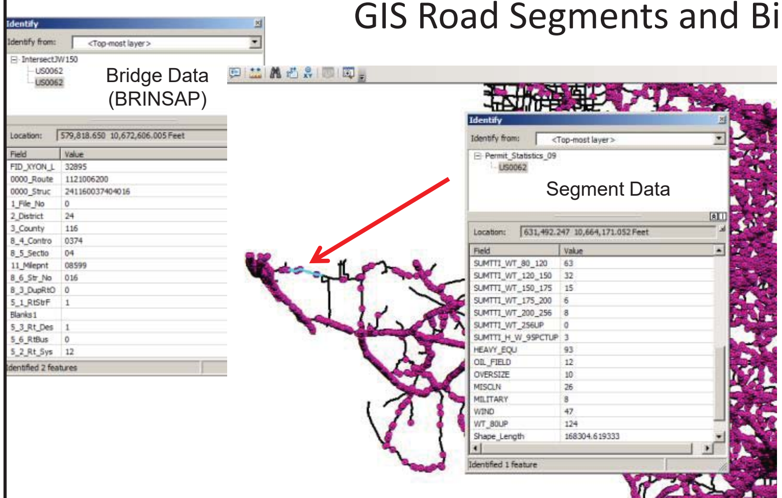
GIS Road Segments and Bidges



County Mileage/Road Class

Each Bridge has a Rated Capacity

Inventory Rating
Operating Rating

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Bridge Fatigue Concepts

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

- ❑ $M_{inventory}$, M_{OSOW}—Live load moments for the Inventory Rating load and OSOW configuration respectively
- ❑ 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

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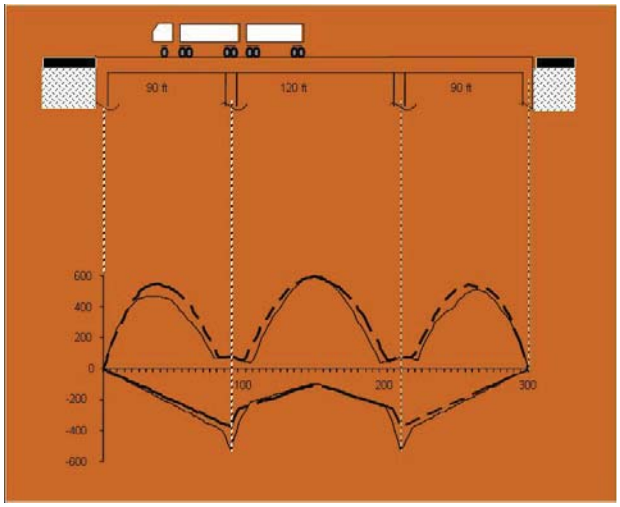
Computerized Bending Moment Envelopes

(Calculation of $M_{inventory}$ M_{OSOW} for network)



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Bridge Consumption – Asset Value

- Asset Value = Deck Area x 200 $/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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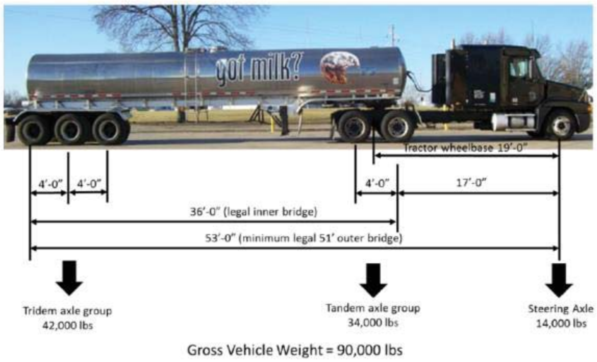
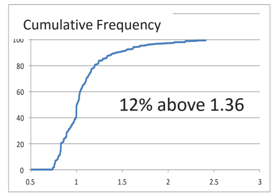
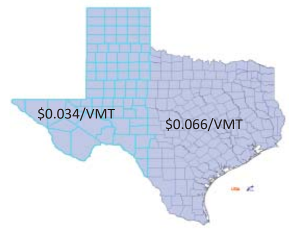
Example



Moment Ratio Based on Inventory Rating





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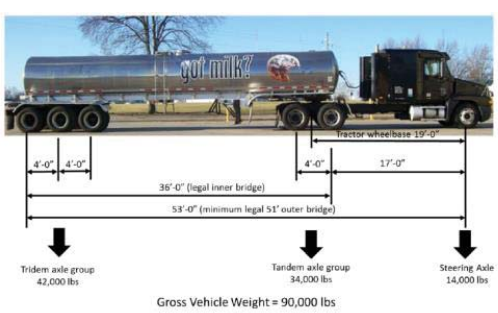
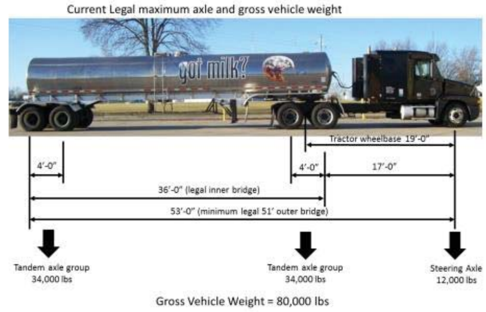
Example Results

Milk Truck	Counties	Random Mileage	Total consumption $	$/VMT	Estimated % above operating rating
Base case 80,000 lb 5-axle truck tractor semi-tank trailer (Legal Load limit)	east	13,002	559.87	0.043	7
	west	19,589	427.09	0.022	
90,000 lb 6-axle truck tractor semi-tank trailer (legal load limit)	east	13,002	858.54	0.066	12
	west	19,589	657.84	0.034	



Current Legal maximum axle and gross vehicle weight



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Summary

- Two types of analysis are possible: Analysis by County/Road Class or Random assignment for an estimated annual mileage.
- Results are reported in terms of bridge consumption per mile driven.
- Results can be reported in terms of absolute costs or incremental costs.

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Step 1. Identify potential truck configurations based on House Bill criteria (GVW, axle weights other factors)

Step 2. Obtain information about milk production and milk trucks operating in Texas

Step 3. Verify milk tank trailer size in relation to GVW

Step 4. Select feasible milk tank truck configurations

Step 5. Perform pavement and consumption analysis

Step 6. Write Legislative Analysis for TxDOT SLA Office

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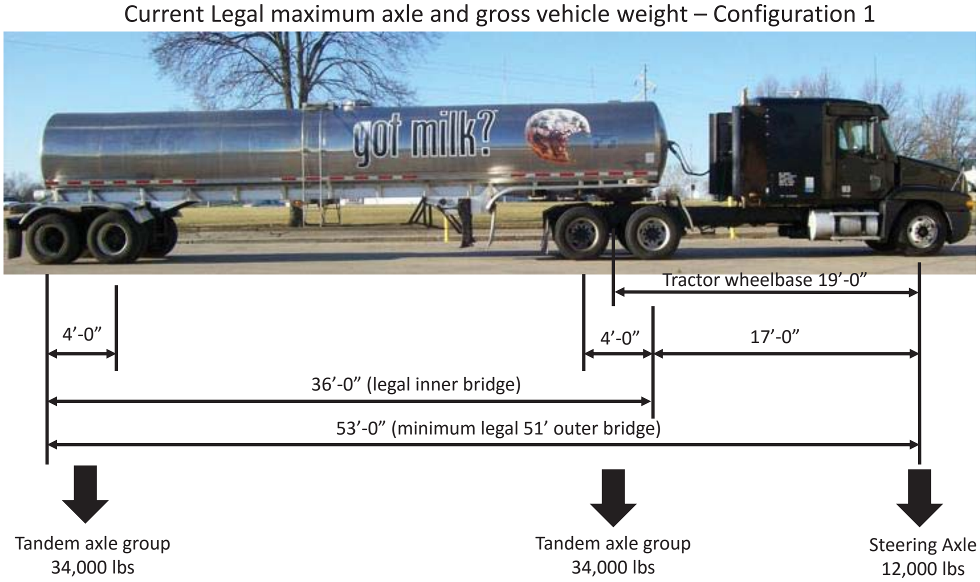
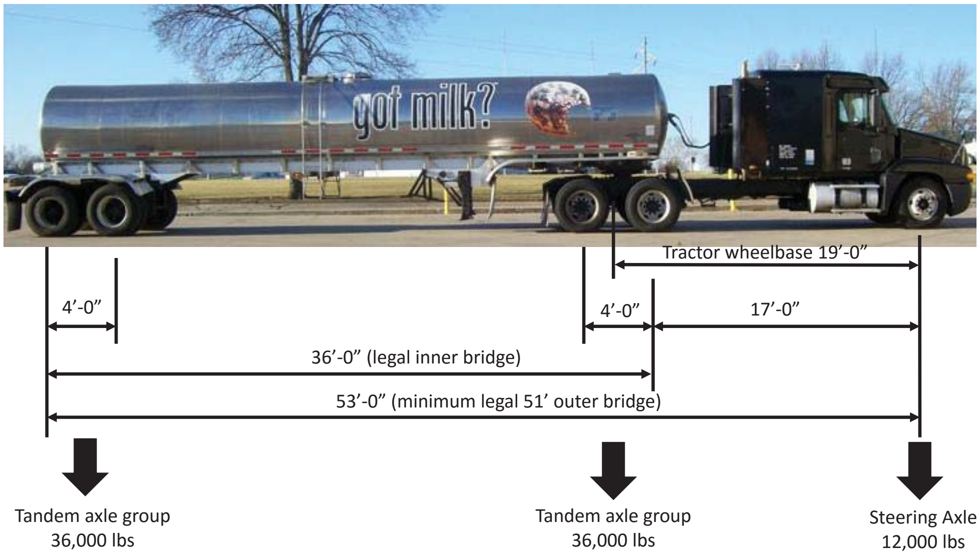
Current Legal maximum axle and gross vehicle weight – Configuration 1



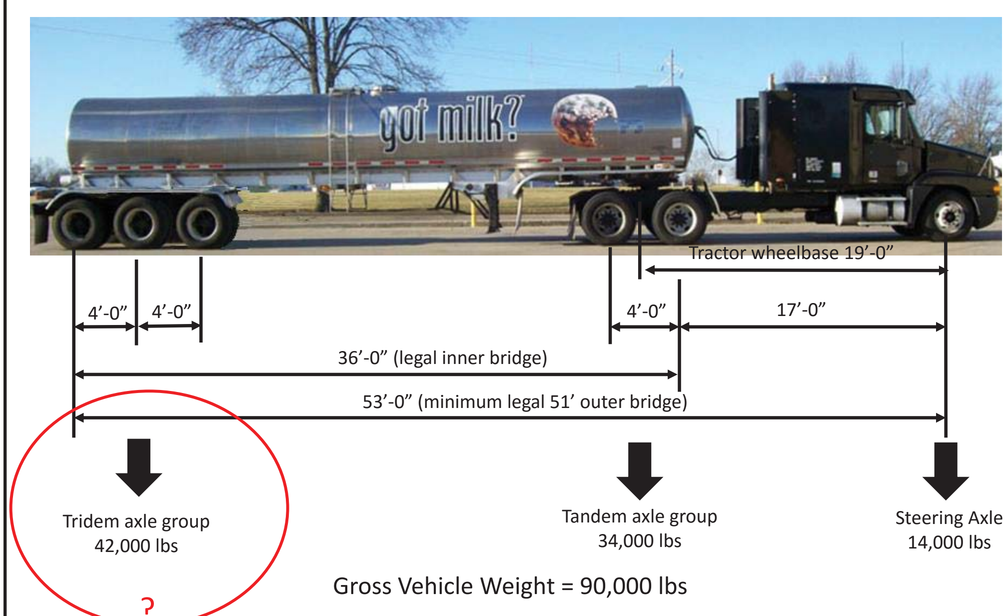
Gross Vehicle Weight = 80,000 lbs

5% over gross vehicle weight and 12% axle tolerance – Configuration 2



Gross Vehicle Weight = 84,000 lbs

HB 3129 90,000 lb gross vehicle weight – Configuration 3



Gross Vehicle Weight = 90,000 lbs

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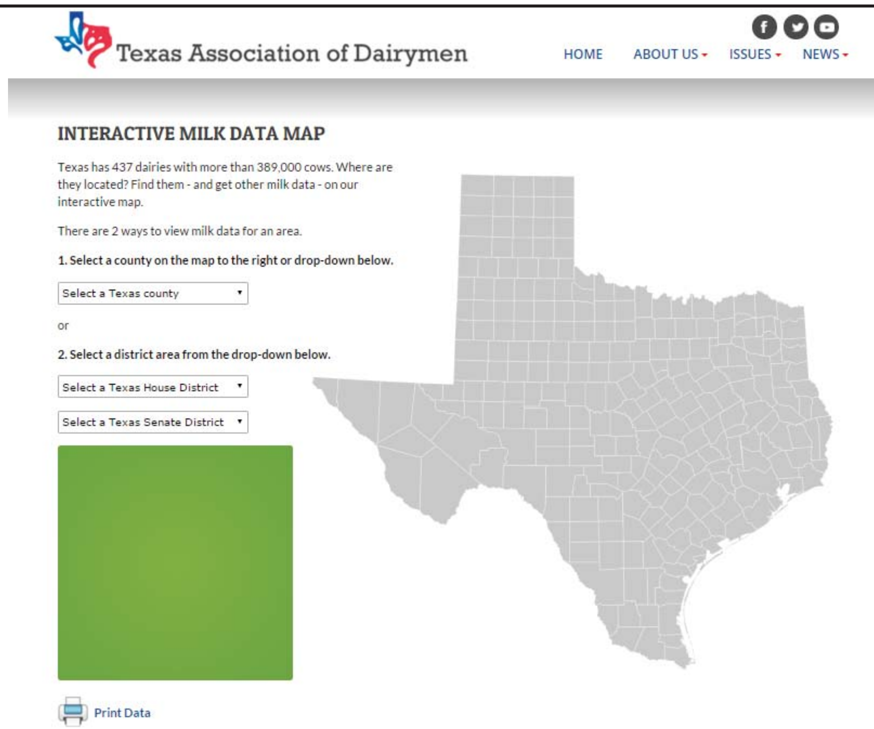

Step 1. Identify potential truck configurations based on House Bill criteria (GVW, axle weights other factors)

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Step 3. Verify milk tank trailer size in relation to GVW

- Polar 'Food Grade'
- Tremcar
- Paul Mueller
- Seneca
- West Mark
- Walker
- Others…..

TREMCAR

QUALITY AND DURABILITY

HOME NEWS PRODUCTS AVAILABILITY CONTACTS FRANÇAIS

FARM PICKUP - 2 AXLES

NEW TANKS : 4 USED TANKS : 0 LEASE TANKS : 1

Click the links above to check availability.

Configuration to meet each province's or State's regulations.

- Capacity of 25 000 to 30 000 Liters (6 000 to 7 800 USG) available.
- Elliptical or round shape.
- Equipped with a spacious back cabinet to house the pump system.
- Choice of tires, suspension, rims, etc..
- Choice of pumps, motors, samplers, etc..

Technical specifications	
Code	3A Sanitary
Working pressure / temp	Atmospheric 180 ° F
Shape	Round, clearbore
Number of compartment	2
Capacity	6 000 to 7 800 USG
Inner tank	T304 stainless steel - #4 finish, dairy polish
Head	T 304 stainless steel - #4 finish, dairy polish
Reinforcing ring	Stainless steel top hat section, fully welded on barrel
Insulation	High density styrofoam 3" thickness, heads and underside with fiberglass
Frame	T304 stainless steel with boxed cross members/outriggers
Outer shell	Prebuff
Outer head	Front: T304 stainless steel - #4 finish - lockformed Rear: T304 stainless steel - #4 finish - welded
Outlet valve	3" Thomsen stainless steel plunger valve with manifold
Manhole	Tremcar 4 lugs - complete with dust cover and sanitary gasket
Vent	One Runovent per manhole
Rear cabinet	Sanitary 3A
Pump	Jabsco 2" (15170)
Motor	2 hp - 208-230V/1/60

Technical specifications (suite)	
Washing system	2 Klenzade balls with one inlet 2" ACME
Sanitary hose	33" X 2" flexible 3A with reducer
Fender	Aluminum contour
Mudflap	Tremcar - white mudflaps
Ladder	Two stainless steel ladders
Walkway	Aluminum Diamond Grip
Suspension	Intraax AA250T
Axle	Included with Intraax
Hubs and drum	Steel hub, 10 stud, hub pilot, cast drum
Wheel	8.25 X 22.5 Steel disc, 10 holes, hub-piloted
Brake	16.5" X 7" quick change with 4S/2M Meritor ABS system
Tire	Aeolus 11R22.5
Nose box	Tremcar - T304 with seven way receptacle
Fifth wheel plate	Bolted, adjustable, heavy duty plate
Landing gear	Jost, 160 000# - 2 speeds
Lights and wiring	Grote wiring and lighting system
Bumper	Heavy duty 4" X 4" stainless steel clad steel tubing
Paint	Primed and painted, mild steel parts only

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Step 1. Identify potential truck configurations based on House Bill criteria (GVW, axle weights other factors)

Step 2. Obtain information about milk production and milk trucks operating in Texas

Step 3. Verify milk tank trailer size in relation to GVW

Step 4. Select feasible milk tank truck configurations

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HB 3129

Analysis of increased Gross Vehicle Weight for milk trucks

Background

HB 3129 (the Bill) would authorize the Texas Department of Motor Vehicles to issue a $500 annual, un-routed permit that would allow a Gross Vehicle Weight (GVW) of 90,000 lbs for a vehicle or combination of vehicles that transport (raw) milk. The permit may be pro-rated for the term of the permit. The permit allows the vehicle to operate on state, county or municipal maintained roads including load-zone roads and Interstate Highway Frontage Roads. The vehicle may not operate on the Interstate Highway System. The permit purchaser is required to designate in which counties the applicant intends to operate. The permit fees are allocated 50% to the State Highway Fund and 50% to the counties named by the applicant when purchasing the permit.

Based on information available at the Texas Association of Dairymen website, Texas has approximately 437 dairies (producers) and 25 raw milk processors which results in approximately 1.194 Billion pounds of milk produced annually. Eleven states produce 77% of the nation's milk and in 2013 Texas ranked 6th nationally in milk production (U.S. Dept. of Agriculture). The Texas Department of Agriculture ranked milk 3rd in terms of cash receipts at $1.8 billion annually behind cotton 2nd at $2.2 Billion and Cattle (1st) at $10.5 billion.

Current Applicable Transportation Code

As an agricultural product, raw milk qualifies for a 5% GVW and a 12% axle weight tolerance exemption from point of production to first point of processing. (TTC Sec. 621.405 and Sec. 621.508) (TxDPS CVE-13) State statutes also provide an exemption that allows a raw milk tank truck to operate with an inner bridge length of 28' (outer distance from the two tandem axle groups) compared to the legal length of 36'. (TTC Sec. 622.031 § (1) (2))

Analysis

Figures 1 - 3 show the three truck configurations analyzed. The analysis assumes that HB3129 does not apply to truck tractor semi-trailers carrying processed milk in cartons for distribution at a grocery store.

CTR / UTSA analysis document

1. Summarizes changes to truck size & weight introduced by the Bill.
2. Lists assumptions and information sources
3. Shows photos of truck configurations, GVW, axle loads and dimensions.
4. Provides a table summarizing Cost per vehicle mile travelled for each configuration $ / VMT.
5. Additional information requested by the legislature.

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3. **Case Study: HB 3129 'Milk trucks weight increase – 90,000 GVW**

4. **Summary and Discussion** — Dr. Mike Walton

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Discussion

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Appendix C: Workshop I Notes

1.1 Welcome and introductions

1.1.1 Opening remarks

Bill Hale set out the objectives and importance of the workshop, which is to gather realistic useful configurations for the library. Consumption estimates will be used in permit pricing.

Trent Thomas explained briefly what organizations are present and introduced Rep. Armando Martinez who will chair a committee on this issue.

Trent explained that TxDOT is preparing for the next legislative session and therefore needs to make assumptions about configurations that may be put into bills.

He noted that permit fees determinations are for the legislature to decide, when bills are filed, TxDOT does not set any fee rates but takes requests for reviewing OSOW bills. These impacts are considered secondary impacts and do not appear in the fiscal notes prepared by the Legislative Budget Board. TxDOT is also asked to give testimony on proposed legislation.

Trent then had all attendees introduce themselves: see sign in sheet for details

1.1.2 Overview of Workshop process

Dr C. Michael Walton talked about previous and ongoing CTR studies related to OS/OW issues. Dr. Walton gave an overview of the SLA Draft Truck Configuration Library project. Dr. Walton noted the AASHTO study was focused on how to make vehicles more compatible with the existing infrastructure and what can be done to improve productivity. He noted that more axles do not necessarily mean less impact on bridges. Sometimes the configurations that are the most accommodating for pavements are bad for bridges.

Dr. Walton spoke about a recently completed national Truck Size & Weight (TS&W) study, which was somewhat unsuccessful due to insufficient data at federal level (; however, we do have more data here in Texas.[1]

The program then turned to a presentation by the research team on the projects goals and objectives, data we need help on and the methodology for bridges and pavements. Dr Mike Murphy, Dr Jorge Prozzi and Dr. Jose Weissmann presented.

Dr. Murphy explained that the basic goal of the consumption analysis is to be commodity neutral; that is to evaluate consumption independent of what the truck is carrying and only considering axle groups, loads and spacing. We often do not necessarily need to know the commodity, but in some cases it is important to know the commodity since a proposed bill may address a specific commodity which is carried in trucks of a specific configuration. In addition,

---

[1] Comprehensive Truck Size and Weight Limits Study summarizes data limitations found in the study:

"…significant limitations in data availability persist, which also affected prior studies. For example, the lack of descriptive information regarding commercial motor vehicles involved in crashes continues to prevent adequate analysis of highway safety and truck crashes. The lack of data on gross vehicle weight (GVW), number of axles on a vehicle, and the spacing between the axles imposed significant constraints in drawing national-level conclusions. In addition, the lack of crash data relevant to oversize trucks impeded the study team's ability to project crash rates of different truck sizes and configurations on a national scale."

existing state statutes might be in place which need to be considered when analyzing a specific commodity such as milk (a liquid) or or loads which are solid

Dr. Murphy noted that we had analyzed different truck configurations for the following house bills in the 84th Legislative Session:

HB 3129: milk tank trucks at 80,000 lbs (base case) 84,000 lbs with a 5% over Gross, (12% over axle weight tolerance) – this is because Texas state statutes authorize agricultural products to be transported during the harvest at these increase weight limits. Two analyses were performed for a 6—axle milk tank truck operating at 90,000 lbs GVWs. Dr. Murphy showed examples of possible milk truck configurations and of questions we would need answered in order to analyze realistic configurations.

- Question: A Workshop attendee asked Dr. Murphy how the steering axle load was set at 14,000 lbs for the 90,000 lb load.
- Response: Dr. Murphy indicated that the tridem trailer axle was set at the maximum allowable limit of 42,000 lbs, the drive tandem on the tractor at 34,000 lbs and the remaining load placed on the steer axle.
- CTR is aware of software that is used by professional trucking companies to calculate the allocation of load to the different axle groups depending on the flexibility available to the driver to move the fifth wheel, move the trailer axles (such as on a dry box van) or the location of the king pin setting. However, not every commodity offers this flexibility; as is the case with a milk tank truck which has fixed trailer axles that cannot be shifted to balance load. CTR has purchased copies of Load Xpert and will analyze axle group loads using this software. Previously, CTR used a freeware program for this purpose (TruckLoad Scale) and though helpful that program does have limitations.
- Additional questions we had regarding the milk tank trucks was the ability to add a third axle to the trailer since there is no super-structure available to add the axle – this suggests that modifications would be required to the trailer undercarriage or a tridem axle tank trailer would have to be purchased.
- We also considered a configuration with an additional, liftable axle added to the tractor; however we are unsure how practical this configuration would be.
- In addition, we take the most conservative approach when analyzing truck configurations when considering load distribution, total VMT. Loaded VMT, and additional factors depending on the type of commodity that may further reduce the loaded VMT. Thus, for milk tank trucks, though we assumed that 42,000 lbs would be carried on the trailer tridem, though we are unsure how a liquid could be distributed to the trailer and drive tandem axles other than equally. Nevertheless, we have studied liquid tankers operating at the border which do have unbalanced loads on the axles – thus we have more to learn about tank trailer load distribution.

HB 3061: sealed ocean containers. The Federal Highway Administration has made the determination that each state can decide whether to pass laws that allow an overweight sealed ocean container to be considered a non-divisible load.

Dr. Murphy showed examples of different container chassis and container combinations to illustrate the fact that there are too many possible configurations. Dr. Murphy mentioned that both 5-axle and 6-axle container chassis were evaluated based on a review of sealed ocean container vehicles authorized in other states, though HB 3061 specifically mentioned that a 6-axle chassis is proposed operating at a maximum Gross Vehicle Weight (GVW) of 97,000 lbs. Other states have enacted legislation that requires heavy 20’ containers to be transported on 40’ chassis in other cases; heavy 20’ containers are not permitted. – the current laws in those states that authorize sealed, heavy ocean containers to operate varies widely.

Dr. Murphy indicated that the Research Team explored chassis manufactured by the major companies in the U.S. including Chassis King, Pratt and Cheetah Chassis. It was noted that one chassis configuration that provides a lower consumption rate compared with many of the tridem axle chassis is the Cheetah Quad. This chassis has a fixed tandem axle and two liftable axles placed about 1/3 of the distance from the king pin to the rear of the trailer. This chassis can carry different container configurations including both heavy 20’ and 40’ containers.

HB 2606: oil well servicing. Dr. Murphy noted that the definition of what constitutes an oil well servicing rig (or workover rig) is not specific and is used by the oil industry to address a wide variety of trucks and configurations. However, oil well service rigs, which are similar in appearance to Oil well drilling rigs, were selected for analysis for HB 2606. In fact it has been learned that Oil Well Drilling Rigs can be used as an oil well service rig. These vehicles y are expensive, and are kept in service for a very long time either by the original company that purchase the unit or by other companies that buy and refurbish the oil well service rig This means that though there are companies that manufacturer new oil well service rigs such as Service King and Dragon from which the vehicle details can be obtained for analysis purposes, there are many other designs in operation that might be more difficult to characterize since the company that produced these units is no longer in business.

HB 2606 would allow 30kips on single axle, 65kips on tandem, 95kips on tridem and 120kips on quadruple axle. Total weight is capped at 135kips. A variety of oil well servicing rigs was shown to the workshop audience.

Oil well service rigs are in operation that are much heavier than 135,000 lbs GVW and it is also noted that during a 3-year period from 2007 – 2009 about 29,000 oil well service rigs were permitted using one of 4 existing permit types offered by the Motor Carrier Division.

It was also noted that the House Bill only addressed self-propelled oil well service rigs though trailer mounted oil well service rigs exist in Texas. Thus, trailer mounted units were not evaluated in the original analysis by the Research Team.

HB 2592: ready mix concrete. This bill would allow ready mix trucks to operate at up to 80,000 lbs GVW depending on the number of axles. Ready mix trucks are in operation in the Austin Area that has an additional, liftable booster axle, liftable booster and pusher axles. There are many different configurations and there are questions which configurations are of interest to industry including both rear discharge and forward discharge ready mix trucks.

Forward discharge ready mix trucks are much more common in Northern States and have a tare weight that is about 10,000 lbs heavier than rear discharge trucks which are most common in Texas. Rear discharge trucks are more expensive, but tend to operate more years than a rear discharge unit – thus the Team questions whether industry is interested in both types. The Team has found a few examples of rear discharge units in operation or for sale in truck sales newspapers.

These questions are important considering the many different axle configurations that are in operation for both forward and rear discharge ready mix trucks.

- Note: During a recent trip to Houston, 6 axle ready mix trucks were seen in operation at two different ready mix / material operations plants.
- The Researchers have noted, based on information obtained from the National Ready Mix Concrete Association annual survey and information obtained from truck sales websites that 10, 10-1/2 and 11 CY ready mix drums are most common on 3-axle trucks and that 11 CY drums are most common on multi-axle ready mix trucks. Thus, based on discussions with

TxDMV – Motor Carrier Division and this above insights, it appears that axles are currently added to allow operation on the Interstate Highway System, not to carry more load.

- It is further noted that the maximum mixer drum size commonly available from Beck or McNeilus is 14 CY. It appears that the proposed House Bill could open the Texas Market to forward discharge ready mix trucks which currently cannot compete with rear discharge units due to the increased tare weight of the forward discharge truck.

Dr. Murphy presented examples of configurations running in several states posed questions we would need to explore to ensure that configurations of interest to industry are included in the Truck Library.

Dr. Jorge Prozzi discussed the Pavement Consumption analysis process that was developed during the Rider 36 (Project 0-6736) study.

The analysis process developed for Rider 36 is based on marginal pavement consumption in relation to a specific truck axle configuration and axle weights. Marginal consumption means that only the weight above the allowable load limit of the pavement is used for the consumption cost calculation.

He explained the AASHTO Road Test, the 4th power damage equation, and the expansion of this concept into a pavement consumption factor. Dr. Prozzi explained relative consumption = ratio between the number of 18-kip axle passes to failure and number of axles to failure at a different weight or axle configuration. Thus, a 20-kip single axle will have a higher pavement consumption value than an 18-kip single axle based on an exponential, 4th power relationship. Dr. Prozzi explained that the pavement consumption models are based on 3 failure criteria:

- International Roughness Index (IRI) – 125 in/mile is terminal condition
- Rutting (1/2” rut depth is terminal condition)
- Fatigue Cracking (10% cracked wheel path area is terminal condition)

The pavement structures and design traffic were obtained for actual pavements representing different functional classes, climatic conditions and other factors relevant to Texas.

The DarWin Mechanistic Empirical (DarWin ME) analysis program was used to perform the calculations. In each case the number of passes of a given Overweight axle was applied to the pavement structure to determine years to failure. The difference between years to failure (typically 20 years) for the design traffic used to develop the actual pavement design and the years to failure under the overweight axle was determined.

Many trial pavement overlay thicknesses were applied to result in a pavement structure that could meet a 20 year design life with the design traffic + overweight loads. The additional thickness was then analyzed to determine cost which was then used to compute $ / VMT.

Questions asked during this segment were:

Question: Please explain again the 4th and nth power equations?

Question: How many pavement types did you analyze?

Answer: it was in the presentation

Question: What is an OS/OW truck?

Answer: anything above the legal weight limit of the pavement keeping in mind that some routes can carry 80,000 lbs GVW but the load zoned roadway system is designed for 58,420 lbs GVW.

Question: If consumption is cost / VMT, there is a reduction in the number of trips if larger trucks are allowed but this is not accounted for in your methodology.

Answer: Dr. Walton explained the uncertainties involved in this type of estimate. Said that he has never seen a study that actually calculated it. There is not enough information.

Question: How are pavements designed? Which configuration?

Answer: explained the standard.

Question: Do you consider the road geometry such as narrow lane width and pavement edge failures?

Answer: no; the 3 failures modes used were roughness (IRI0, rutting and fatigue cracking

Dr. Weissmann then explained data sources for bridge analysis, and how we overlap the bridge data to the highway data, since the result must be $/VMT. Dr. Weissmann explained inventory versus operating bridge ratings. The methodology compares moment envelopes of OSOW load to the inventory load. It also calculates marginal cost. Moment ratios may cap the analysis due to safety considerations.

The asset value of the bridge is estimated as $200/sq. ft. A federal study recommended that 11% of the cost is due to trucks. Dr. Weissmann showed the milk truck analysis from last legislative session.

1.1.3 Case study summary Discussion

The workshop began a discussion session for dialogue with industry and other representatives and to give a question and answer session. Note: numbered questions are from audience.

Question 1

How do you incorporate consumption costs into a fee structure?

Dr. Walton noted he had never seen a fee structure that actually pays for all the damage.

Dr. Prozzi noted that this method uses Marginal pavement + bridge + safety costs per VMT. The analysis is predicated on the concept of "If we could predict the OS/OW traffic, how much stronger should the pavement be?" We then calculate the cost to build a pavement to withstand such traffic. Dr. Prozzi mentioned several possible options to design a pavement based on life-cycle-costs to illustrate why it is not practical to do such analyses in this case.

Question 2

Does TxDOT consider overweight traffic when designing a pavement?

Dr. Prozzi noted that it was very difficult to estimate traffic over 20 years. We work with averages. TxDOT uses traffic volume and weigh in motion data to determine average truck weights for a given vehicle class. Districts must provide additional information to the Transportation Planning & Programming Division if a local heavy truck generator (such as a quarry, landfill, or ready mix plant) exists along a route for which pavement design traffic data is requested.

Dr. Weissmann noted that bridges have a design life that is consumed depending on the moment ratio and the materials. We do the analysis on a bridge by bridge basis.

Question 3

For the determination of traffic routing and traffic routes, especially for non-routed permits how do you take into account routes if you don't have that information?

Dr. Prozzi: this is not a big issue. The variation of pavement structures impacts more on the analysis.

Dr. Prozzi stated that the general trend is Continuously Reinforced Concrete Pavement (CRCP) is very robust and marginal cost is lower than flexible pavements. However, the initial construction cost of CRCP is much higher than for many flexible pavements, thus CRCP is typically used on very high traffic routes in metro areas where closing a lane of traffic to perform repairs or rehabilitation is expensive. Thus, in first 20 years of pavement life CRCP pavements may not require much maintenance whereas a flexible pavement might require an overlay. Each site has its own conditions such as climate, subgrade soil, traffic, local materials availability etc.

Dr. Weissmann noted that it depends on the project objectives. Sometimes we are asked to analyze one or more particular corridors. If not, the options are:

(1) a random route assignment to estimate the mileage,

(2) cost/VMT by road class and/or county and/or region and/or urban/rural area. The only way to take into account actual routes is if the industry puts a GPS in each truck, prepares a geo-referenced database of passes over each route, and give it to us.

Question 4

Panhandle traffic. There are less OS/OW there than in the rest of Texas, especially East Texas.

The team noted that engineers are aware of that and take that into account in the design and construction.

Question 5

A representative from the timber industry indicated that his trucks have been weighed by DPS using portable scales, found to be overweight which resulted in a fine. However, when the truck arrived at the sales location, it was weight 2,000 lbs lighter - what can be done about this?

Question is outside the scope of this project, suggested to talk to DPS.

Dr. Walton then asked a question of our audience. Is there any guidance with respect to upcoming proposed configurations we should consider in our analyses?

Nobody suggested a configuration.

Question 6

Whether or not we consider a reduction in number of trucks if they are allowed to be heavier, and if not, why.

Dr. Walton noted that neither Texas nor the federal agencies have done a cost allocation study in quite a while. Other states have. We don't have this information or the data to estimate the reduction. It is believed that such reductions do not matter because the baseline trucks have no fee at all.

Dr. Murphy gave an example that occurred in Illinois where soy bean farmers, container trucks and rail took advantage of the new sealed ocean container permit process to create new opportunities and market for the industry and eventually increased the numbers of trucks in the area. Empty ocean containers were used to transport soy beans from the field to intermodal rail yards where they were shipped to the Great Lakes and the St. Lawrence Sea Way for international export.

Question 7

The industry would prefer to know which vehicle configurations would be better for the infrastructure, so that we could decide what to do.

Dr. Murphy stated that we looked at what other states are doing so we suggest, but we still need your input as to whether or not you are interested.

Dr. Walton noted that it is important to get ahead of this curve. Investments are required on both parts.

Question 8

Can we use the library in reverse, i.e. to make recommendations on how to design pavements and bridges?

Mark McDaniel of Austin District at TxDOT briefly mentioned pavement design (AASHTO), Rider 36 and other studies' methodology. He explained that the library objective is the fiscal impacts. Mr. McDaniel agreed with the assertion that industry runs their own analyses.

Question 9

We look at 20-year design lives. Can we use the tool in reverse to see what the savings would be?

Mr. McDaniel noted that typically when we run the analysis and find that the consumption is greater than for normal traffic it is a shortening of the structural life. For example, it is not economical to rebuild roads affected to withstand heavier trucks. It would be too expensive.

Comment from audience

Statements like "we don't have the money" can be interpreted as implying "therefore we will make you (the trucking industry) give it to us (State Government)."

Dr. Murphy noted that Texas issues over 800,000 permits per year. It is impossible to predict what will happen globally in the next 20 years that may create the need for heavy loads. Examples: a tsunami in Japan resulted in the immediate need for heavy electrical transformers that moved westward across Texas to California. Hundreds of wind turbines have been constructed in different areas of the state which resulted in unplanned, new OS/OW loads traveling to west and central Texas.

The audience indicated that shale fracking and oil production in the Permian Basin, Eagleford and Barnett Shale plays had significantly increased OS/OW truck traffic in regions of the state.

Question 10

There is a finite amount of cattle that we transport. If you increase weight limit we will decrease the number of trucks.

Dr. Murphy stated that we must consider the larger picture. For example, silage which is an agricultural product and therefore can take advantage of higher weight limits is needed to feed the cattle and other livestock and is often being transported on load zoned FM roads. This can result in unplanned expensive repairs which a district must address due to safety concerns – this means other planned projects must be delayed to repair the damaged routes. These routes are often damaged by custom harvesting operations that are located out of state, travel to Texas for the Summer and Fall harvests and then move north through Oklahoma until they reach Canada. Thus, the custom harvesters have made money as has the location agricultural community but the district is left trying to fund the repairs with no additional money.

Mr. McDaniel noted that TxDOT must look at the overall network: cargo fleets into ports, containers that potentially could go anywhere. That is what complicates the consumption analyses.

1.2 Closing

Trent wrapped up by noting that if TxDOT is called out to testify as witness, it will say what the impacts are. The turnaround for analysis is very quick, sometimes less than 5 days. TxDOT will use the library as reference.

TxDOT is advocating neither against nor for OSWO, all TxDOT does is provide information for the legislature to make decisions.

1.3 Workshop Attendee Lists

A list of workshop attendees can be found in Appendix A to this Technical Memo.

1.4 Workshop Powerpoint

The workshop powerpoint presentation is attached as a separate appendix to this Technical Memorandum.

1.5 Other Meetings

A follow up discussion with Bob Fogarty – an engineer with Cheetah Chassis has resulted in his offer to conduct a workshop in Austin, his company’s expense, which he calls ‘Chassis and Container 101’. This workshop was developed to help educate a broad based audience in the design and operational consideration related to container chassis.

Bob indicated he is available in April – The research team has developed a tentative date for the workshop, which would be paired with a workshop for project 0-6820 subject to further discussions with TxDOT.

In addition, prior to the SLA Workshop and after the Workshop, opportunities to visit industry trade groups or specific companies were extended to CTR/UTSA researchers.

A meeting was held with the Texas Trucking Association – Intermodal Committee on March 8 in Houston at the Gulf Intermodal Company headquarters. Due to scheduling conflicts Dr. Mike Murphy was the only representative available to meet that day. The meeting included the following individuals

- **John Esparza** (CEO – TxTA)
- **Les Findeisen** (Government Relations – TxTA)
- **Mark Borskey** – Borkey Government Relations LLC
- **Marcia Faschingbauer** – Excargo
- **BJ Tarver** – Gulf Winds International
- **Chester Loth** – EMTL (Empire Truck Lines)
- **Will Conner** – Gulf Intermodal
- **Rick Maddox** – Canal Cartage
- **Brian Fielkow** CEO - Jetco Delivery
- Name unknown – container chasis pool operator
- Name unknown - representative of container chassis truck drivers.

The main discussion points of the meeting included:

- Discussed a number of issues relating to a heavy container corridor in Houston. There is not a consensus within the Committee whether an overweight corridor (like those at Brownsville, HCRMA etc.) or even the container bill is in the best interests of the trucking companies or those who operate the chassis pool(s).
- Experience in other states has been that additional fees could be charged to customers for overweight containers in the 1st year and perhaps the 2nd; after than the customers refuse to pay the additional cost because it is now standard practice.
- Customers may refuse to pay increased costs associated with permit fees even if they can transport more load. One committee member indicated that if the contents of 5 containers can be carried in 4 heavier trucks, he's lost business, not increased it.
- Private truckers that haul containers are often not paid anymore to haul heavier loads which increases their costs (fuel, tires, maintenance, and affects safety.
- The group thinks that the over weight containers are mainly of interest to the pelletized resin manufacturers. Other industries that are not transporting loads in containers might want the same rules to apply to them so that they can haul oil field equipment, etc. at the same costs.
- I was asked why we did not consider the benefit of fewer trucks due to the increased load. I responded by saying that we don't know what the consequences of allowing heavier containers might be - in Illinois, soy bean farmers worked with container companies, truckers and rail to fill empty containers moved by truck from the field to a rail yard for shipment overseas. Their market was expanded, but this resulted in more, not fewer trucks on the road.
- I was asked several times how increased weights would affect bridges in Houston. I gave an overview of the bridge fatigue concepts but said that Jose would need to explain the

details. I offered to have a meeting at CTR with the group to conduct a workshop on pavement and bridge consumption concepts - these types of meetings can help each group better understand the challenges and concerns to help unify the parties involved.

- The group said that the following corridors would be of interest, but would send you an email confirming these routes for consideration in project 0-6817.
  - a) SH 225 from IH 610 to SH 146 (about 14.5 miles)
  - b) SH 146 from US 90 to IH 45.(about 29.1 miles)

- The group indicated that they would be interested in assessing these routes for 5 and 6 axle heavy containers including heavy 20' containers on 40' chassis, the Cheetah quad, and a 20' slider chassis. I noted that 20' chassis in Houston include both short and longer goose-neck units. Also there are split tandems operating in Houston, which may be interesting to evaluate to compare consumption rates.
- John Espinoza was interested in knowing about the brochure published by the governor's office promoting the state's resin manufacturing capabilities.

Dr. Murphy visited the Barbours Cut Container Terminal and took a number of photos both inside and outside the terminal of container chassis configurations and containers mounted on chassis of various configurations.

- During the photo session in Barbours Cut – Port Police met with Dr. Murphy and requested him to talk to the Department of Homeland Security by phone to explain why he was taking photos. Dr. Murphy was requested to obtain a letter from TxDOT on TxDOT letter head advising of the purpose of the photo documentation. This letter was supplemented by a request to take photos and other documentation.
- Dr. Murphy was allowed to keep the photos he took which will be used to help analyze configurations for HB 3061.
- Dr. Murphy also traveled the length of SH 146 (South from US 90 to IH 45 and North from IH 45 to IH 10E. He also traveled SH 225 West from SH 146 to IH 610 and East from IH 610 to SH 146. Though these trips were informative, it was raining heavily which obscured some details. It was noted that an LTPP test section is still marked on SH 146 south of IH 10 that could be helpful regarding detailed pavement information if analysis of these corridors is pursued.

In addition, after Workshop I, Mr. Thomas Howard with Domtar paper ((803-802-8041) , located in southern Arkansas met to discuss his company’s interest in the Container Bill to allow paper products to be transported from a plant in southern Arkansas through a portion of Texas to eastern destinations. In addition, Mr. Howard indicated that Domtar is interested in potential container shipments to the Alliance Intermodal Yard in Dallas.

Further Daniel Waumach with Dow Chemical contacted Dr. Murphy to request a meeting with Dow Chemical’s truck operations personnel regarding HB 3061. Daniel indicated that Dow Chemical is interested in this Bill and would like to discuss their preferences. (512) 636-6243

Appendix D: Ocean Container Analysis Summary

TARE WEIGHT

The weight of tractor for all configurations is assumed as 16,620 lbs, including 1,200 lbs for steer axle, 1,910 lbs for each axle in a drive axle group. The tare weights of each chassis configurations are listed below, including 1,620 lbs for each axle in a tridem axle group, a tandem axle group, or a liftable axle:

NO.	1	2	3	4	5	6	7	8	9	10	11	12	21	22	23	24
Tare Weight	24,980	24,980	24,980	25,980	23,980	23,980	23,980	28,320	28,320	28,320	29,940	29,940	29,496	31,406	29,156	31,066
Tractor Weight	16,620	16,620	16,620	16,620	16,620	16,620	16,620	16,620	16,620	16,620	16,620	16,620	15,996	17,906	15,996	17,906
Chassis Weight	8,360	8,360	8,360	9,360	7,360	7,360	7,360	11,700	11,700	11,700	13,320	13,320	13,500	13,500	13,160	13,160

OVERVIEW OF ANALYSIS

In the analysis, the following are conducted:

For configuration NO. 1-7: Weight distributions for GVW of 80,000 lbs, 97,000 lbs, and maximum GVW the configuration can carry were analyzed;

For configuration NO. 8-12: Weight distributions for GVW of 97,000 lbs, and maximum GVW the configuration can carry were analyzed;

For configuration No. 21-24: Weight distributions for GVW of 80,000 lbs, 90,000 lbs, 97,000 lbs, 102,000 lbs and maximum GVW the configuration can carry were analyzed.

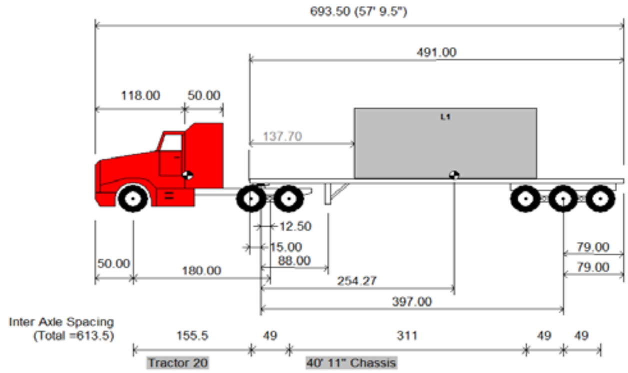
NO.	Container	Chassis Length	Tandem Spacing	Tridem Spacing	Liftable Axle	Violation 80,000 GVW*	Violation 90,000 GVW*	Violation 97,000 GVW*	Violation 102,000 GVW*	Maximum GVW under FBF
1	20'	40'11"	-	98"	-	None	-	1-5, **1-6**, 2-3, 2-5, 2-6, 3-6, **4-6**	-	84,000 lbs
2	20'	40'11"	-	109"	-	None	-	1-5, **1-6**, 2-3, 2-5, 2-6, 3-6, **4-6**	-	84,500 lbs
3	20'	40'11"	-	122"	-	None	-	1-5, **1-6**, 2-5, 2-6, 3-6, **4-6**	-	84,500 lbs
4	20'	53'	-	122"	-	None	-	1-5, **1-6**, 2-6, **4-6**	-	89,721 lbs
5	40'	40'	-	98"	-	None	-	1-5, **1-6**, 2-5, 2-6, 3-6, **4-6**	-	83,500 lbs
6	40'	40'	-	109"	-	None	-	1-5, **1-6**, 2-5, 2-6, 3-6, **4-6**	-	84,000 lbs
7	40'	40'	-	122"	-	None	-	1-5, **1-6**, 2-5, 2-6, 3-6, **4-6**	-	84,000 lbs

NO.	Container	Chassis Length	Tandem Spacing	Tridem Spacing	Liftable Axle	Violation 80,000 GVW*	Violation 90,000 GVW*	Violation 97,000 GVW*	Violation 102,000 GVW*	Maximum GVW under FBF
8	40'	53'	-	98"	-	-	-	1-5, **1-6**, 2-6, **4-6**	-	87,745 lbs
9	40'	53'	-	109"	-	-	-	1-5, **1-6**, 2-6, **4-6**	-	88,640 lbs
10	40'	53'	-	122"	-	-	-	1-5, **1-6**, 2-6, **4-6**	-	89,663 lbs
11	40'	53'	-	122"	6,250 lbs	-	-	1-6, **1-7**, 2-7	-	96,500 lbs
12	40'	53'	-	122"	11,000 lbs	-	-	1-6, **1-7**, 2-7	-	96,500 lbs
21	40'	53'	-	122'	-	None	4-6	**1-6**, 2-6, 4-5, 4-6, 5-6	1-6, 2-3, 2-6, 3-6, 4-5, 4-6, 5-6	89,504 lbs
22	40'	53'	-	122'	-	None	5-7	2-7, 5-6, 5-7, 6-7	1-7, 2-7, 3-7, 5-6, 5-7, 6-7	97,000 lbs
23	40'	51'	-	128'	-	None	2-6, 4-6	**1-6**, 2-3, 2-6, **4-6**	1-3, 1-5, 1-6, 2-3, 2-5, 2-6 4-5, 4-6, 5-6	89,999 lbs
24	40'	51'	-	128'	-	None	None	2-7**,** **5-7**	1-7, 2-7, 3-7, 5-7	96,009 lbs

*All axle and inter-axle weights that violate the Bridge Formula B requirements are listed. Specifically, for GVW of 97,000, a group number in red and bold represents cases where the inter-axle weight violates Bridge Formula but comply with SLA axle group weight requirements**.
**Accroding to the scope of the SLA study, the weight limits for trucks carrying ocean containers are 97,000 lbs for GVW, 20,000 lbs for single axle, 34,000 lbs for tandem axle group, and 51,000 lbs for tridem axle group.

Conf. 1: 40’11’’ Chassis with tridem axle spacing 98’’

1-1. 80,000 lb GVW

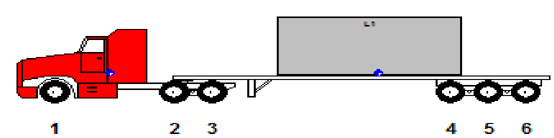


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10069	7952	6958	24980
Accessories:	0	0	0	0
Payload:	1485	19899	33636	55020
Total:	11554	27852	40594	80000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	11554	5 - 6	34000	27063						
2	20000	13926									
3	20000	13926									
4	20000	13531									
5	20000	13531									
6	20000	13531									
1 - 2	40000	25480									
1 - 3	48500	39406									
1 - 4	70500	52937									
1 - 5	77500	66469									
1 - 6	80000	80000									
2 - 3	34000	27852									
2 - 4	58500	41383									
2 - 5	64500	54914									
2 - 6	71500	68446									
3 - 4	40000	27457									
3 - 5	58500	40988									
3 - 6	64500	54520									
4 - 5	34000	27063									
4 - 6	42000	40594									

◀ = U.S. Bridge Formula Violation

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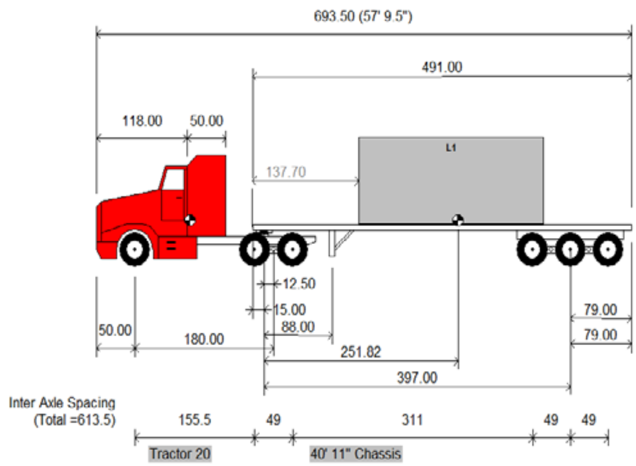
1-2. 97,000 lb GVW

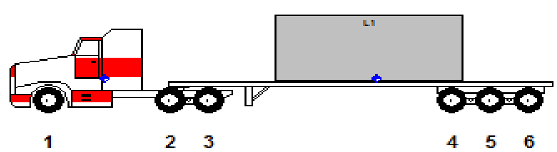


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10069	7952	6958	24980
Accessories:	0	0	0	0
Payload:	1944	26048	44028	72020
Total:	12013	34000	50987	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



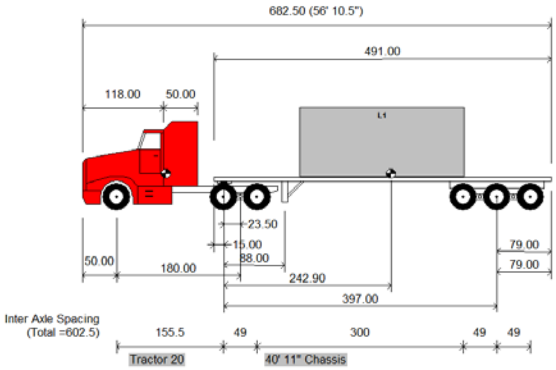
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	12013		5 - 6	34000	33991									
2	20000	17000													
3	20000	17000													
4	20000	16996													
5	20000	16996													
6	20000	16996													
1 - 2	40000	29013													
1 - 3	48500	46013													
1 - 4	70500	63009													
1 - 5	77500	80004	◄												
1 - 6	80000	97000	◄												
2 - 3	34000	34000	◄												
2 - 4	58500	50996													
2 - 5	64500	67991	◄												
2 - 6	71500	84987	◄												
3 - 4	40000	33996													
3 - 5	58500	50991													
3 - 6	64500	67987	◄												
4 - 5	34000	33991													
4 - 6	42000	50987	◄												

◄ = U.S. Bridge Formula Violation **Page 1 of 1**

1-3. Maximum Payload under U.S Bridge Formula

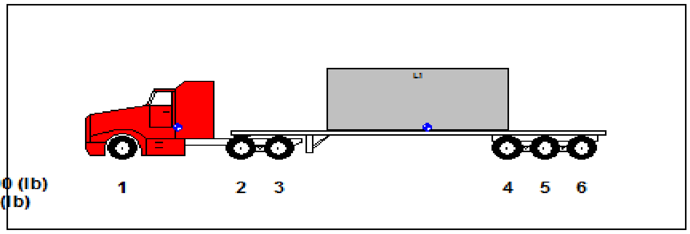


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10155	7867	6958	24980
Accessories:	0	0	0	0
Payload:	3232	21521	34267	59020
Total:	13387	29388	41226	84000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	13387	5 - 6	34000	27484						
2	20000	14694									
3	20000	14694									
4	20000	13742									
5	20000	13742									
6	20000	13742									
1 - 2	40000	28081									
1 - 3	48500	42774									
1 - 4	70000	56516									
1 - 5	76500	70258									
1 - 6	84000	84000									
2 - 3	34000	29388									
2 - 4	57500	43130									
2 - 5	64000	56872									
2 - 6	71000	70613									
3 - 4	40000	28436									
3 - 5	57500	42178									
3 - 6	64000	55919									
4 - 5	34000	27484									
4 - 6	42000	41226									

◄ = U.S. Bridge Formula Violation

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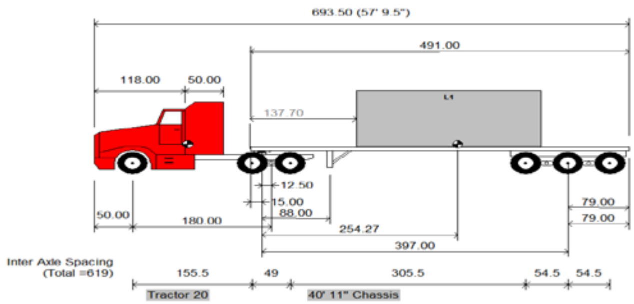
Conf. 2: 40’11’’ Chassis with tridem axle spacing 109’’

2-1. 80,000 lb GVW



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10069	7952	6958	24980
Accessories:	0	0	0	0
Payload:	1485	19899	33636	55020
Total:	11554	27852	40594	80000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

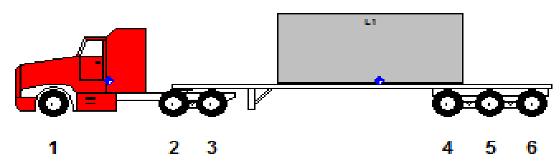
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	11554	5 - 6	34000	27063						
2	20000	13926									
3	20000	13926									
4	20000	13531									
5	20000	13531									
6	20000	13531									
1 - 2	40000	25480									
1 - 3	48500	39406									
1 - 4	70500	52937									
1 - 5	77500	66469									
1 - 6	80000	80000									
2 - 3	34000	27852									
2 - 4	58500	41383									
2 - 5	64500	54914									
2 - 6	72500	68446									
3 - 4	40000	27457									
3 - 5	58500	40988									
3 - 6	65500	54520									
4 - 5	34000	27063									
4 - 6	42500	40594									

◀ = U.S. Bridge Formula Violation

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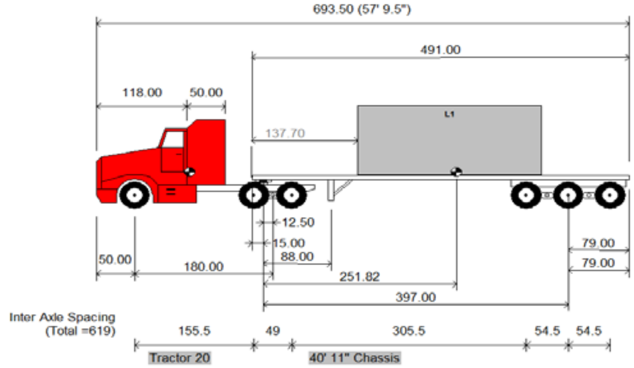
2-2. 97,000 lb GVW

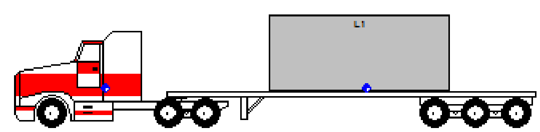


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10069	7952	6958	24980
Accessories:	0	0	0	0
Payload:	1944	26048	44028	72020
Total:	12013	34000	50987	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	12013		5 - 6	34000	33991									
2	20000	17000													
3	20000	17000													
4	20000	16996													
5	20000	16996													
6	20000	16996													
1 - 2	40000	29013													
1 - 3	48500	46013													
1 - 4	70500	63009													
1 - 5	77500	80004	◀												
1 - 6	80000	97000	◀												
2 - 3	34000	34000	◀												
2 - 4	58500	50996													
2 - 5	64500	67991	◀												
2 - 6	72500	84987	◀												
3 - 4	40000	33996													
3 - 5	58500	50991													
3 - 6	65500	67987	◀												
4 - 5	34000	33991													
4 - 6	42500	50987	◀												

◀ = U.S. Bridge Formula Violation

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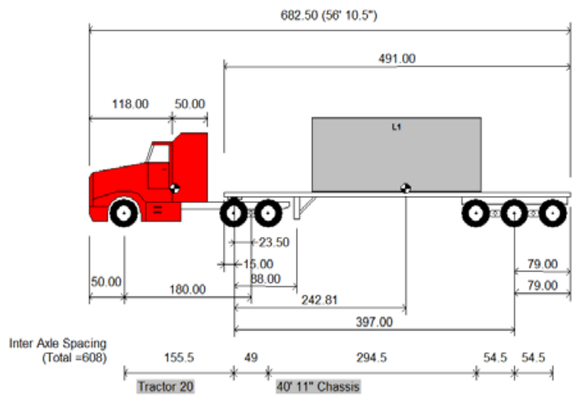
2-3. Maximum Payload under U.S Bridge Formula

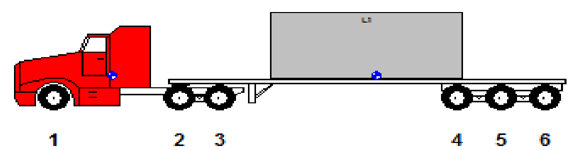


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10155	7867	6958	24980
Accessories:	0	0	0	0
Payload:	3259	21703	34558	59520
Total:	13414	29570	41516	84500
Desired/(GVW)*:	U.S. Bridge Formula			-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



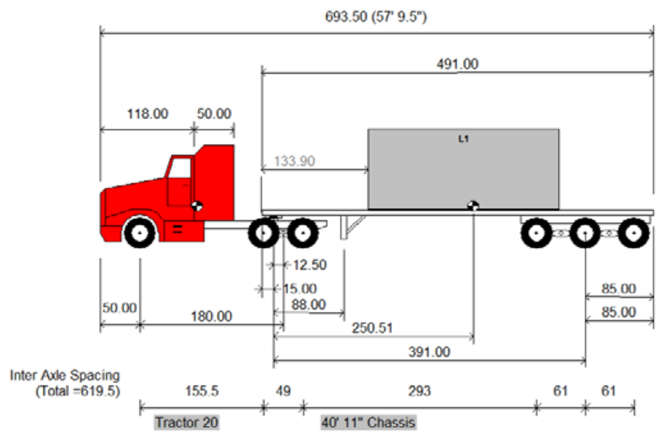
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb
1	20000	13414	5 - 6	34000	27677						
2	20000	14785									
3	20000	14785									
4	20000	13839									
5	20000	13839									
6	20000	13839									
1 - 2	40000	28199									
1 - 3	48500	42984									
1 - 4	70000	56823									
1 - 5	76500	70661									
1 - 6	84500	84500									
2 - 3	34000	29570									
2 - 4	57500	43409									
2 - 5	64000	57247									
2 - 6	71500	71086									
3 - 4	40000	28624									
3 - 5	57500	42462									
3 - 6	64500	56301									
4 - 5	34000	27677									
4 - 6	42500	41516									

Conf. 3: 40’11’’ Chassis with tridem axle spacing 122’’

3-1. 80,000 lb GVW

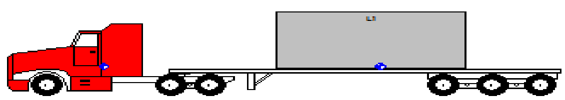


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10067	7922	6990	24980
Accessories:	0	0	0	0
Payload:	1486	19917	33617	55020
Total:	11553	27839	40608	80000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	11553	5 - 6	34000	27072						
2	20000	13920									
3	20000	13920									
4	20000	13536									
5	20000	13536									
6	20000	13536									
1 - 2	40000	25473									
1 - 3	48500	39392									
1 - 4	69500	52928									
1 - 5	77500	66464									
1 - 6	80000	80000									
2 - 3	34000	27839									
2 - 4	57500	41375									
2 - 5	64500	54911									
2 - 6	72500	68447									
3 - 4	40000	27455									
3 - 5	58500	40991									
3 - 6	65500	54527									
4 - 5	34000	27072									
4 - 6	43500	40608									

◄ = U.S. Bridge Formula Violation

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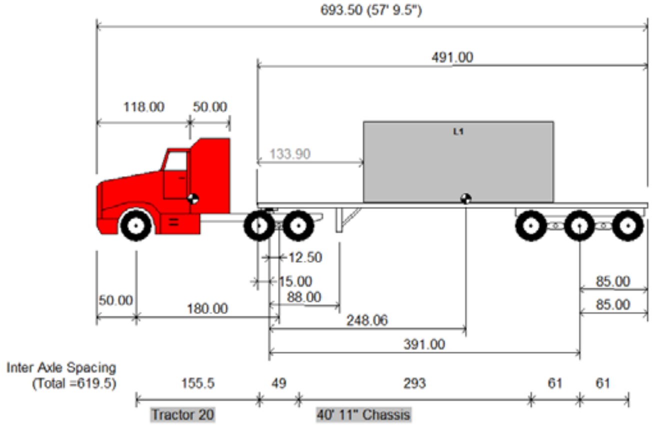
3-2. 97,000 lb GVW



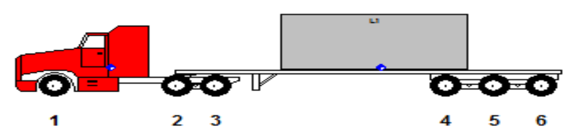
Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10067	7922	6990	24980
Accessories:	0	0	0	0
Payload:	1946	26070	44004	72020
Total:	12013	33993	50994	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

BRIDGE FORMULA OPTION:
Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb	
1	20000	12013		5 - 6	34000	33996									
2	20000	16996													
3	20000	16996													
4	20000	16998													
5	20000	16998													
6	20000	16998													
1 - 2	40000	29009													
1 - 3	48500	46006													
1 - 4	69500	63004													
1 - 5	77500	80002	◄												
1 - 6	80000	97000	◄												
2 - 3	34000	33993													
2 - 4	57500	50991													
2 - 5	64500	67989	◄												
2 - 6	72500	84987	◄												
3 - 4	40000	33995													
3 - 5	58500	50993													
3 - 6	65500	67991	◄												
4 - 5	34000	33996													
4 - 6	43500	50994	◄												

◄ = U.S. Bridge Formula Violation

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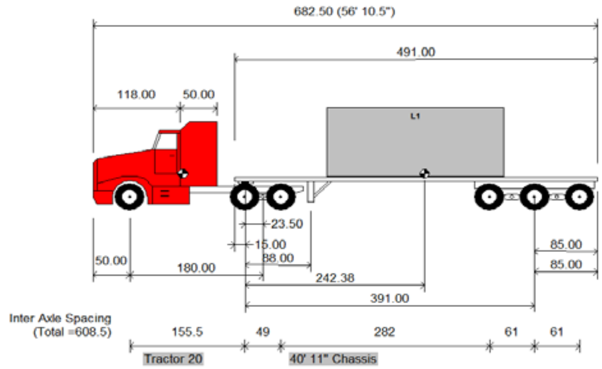
3-3. Maximum Payload under U.S Bridge Formula



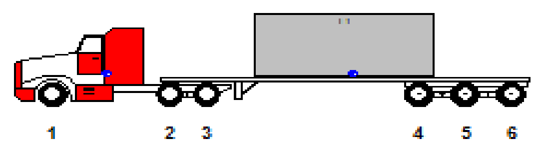
Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10151	7839	6990	24980
Accessories:	0	0	0	0
Payload:	3190	21242	35088	59520
Total:	13341	29081	42078	84500
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

BRIDGE FORMULA OPTION:
Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	llowabl Load (lb	Current oad (lb	Axle Bridge	llowabl Load (lb	Current oad (lb	Axle Bridge	llowabl Load (lb	Current oad (lb	Axle Bridge	llowabl Load (lb	Current oad (lb
1	20000	13341	5 - 6	34000	28052						
2	20000	14541									
3	20000	14541									
4	20000	14026									
5	20000	14026									
6	20000	14026									
1 - 2	40000	27881									
1 - 3	48500	42422									
1 - 4	69500	56448									
1 - 5	76500	70474									
1 - 6	84500	84500									
2 - 3	34000	29081									
2 - 4	57000	43107									
2 - 5	64000	57133									
2 - 6	71500	71159									
3 - 4	40000	28567									
3 - 5	57500	42593									
3 - 6	64500	56619									
4 - 5	34000	28052									
4 - 6	43500	42078									

◀ = U.S. Bridge Formula Violation

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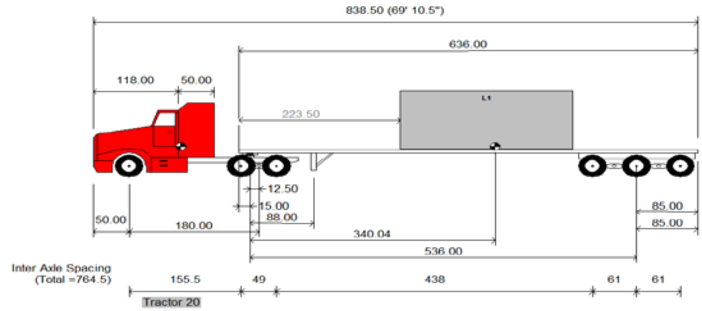
Conf. 4: 53’ Chassis with tridem axle spacing 122’’

4-1. 97,0000 lb GVW

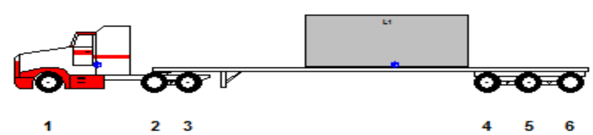


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10103	8410	7467	25980
Accessories:	0	0	0	0
Payload:	1909	25584	43526	71020
Total:	12013	33994	50993	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb	
1	20000	12013		5 - 6	34000	33995									
2	20000	16997													
3	20000	16997													
4	20000	16998													
5	20000	16998													
6	20000	16998													
1 - 2	40000	29010													
1 - 3	48500	46007													
1 - 4	78000	63005													
1 - 5	80000	80002	◄												
1 - 6	80000	97000	◄												
2 - 3	34000	33994													
2 - 4	60000	50992													
2 - 5	72500	67990													
2 - 6	80000	84987	◄												
3 - 4	40000	33995													
3 - 5	60000	50992													
3 - 6	73500	67990													
4 - 5	34000	33995													
4 - 6	43500	50993	◄												

◄ = U.S. Bridge Formula Violation

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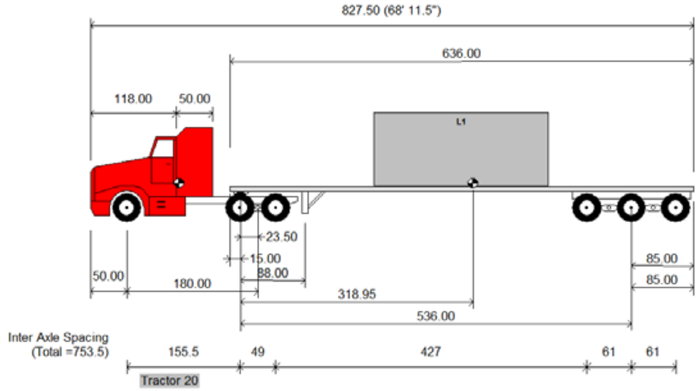
4-2. Maximum Payload under U.S Bridge Formula

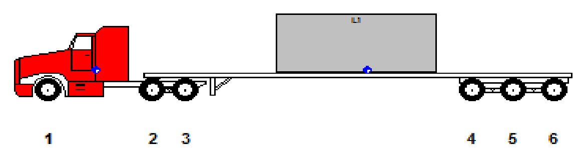


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10219	8294	7467	25980
Accessories:	0	0	0	0
Payload:	3617	24091	36033	63741
Total:	13837	32385	43500	89721
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

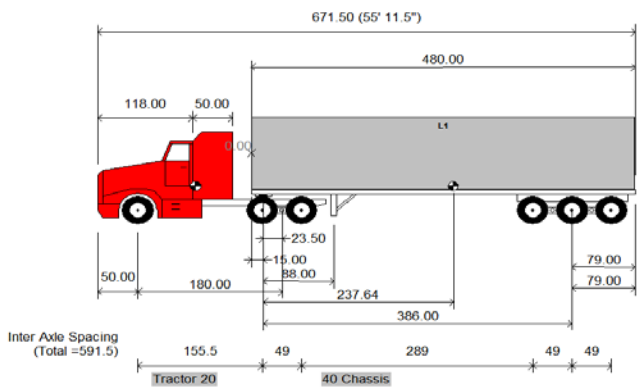
Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	13837	5 - 6	34000	29000						
2	20000	16192									
3	20000	16192									
4	20000	14500									
5	20000	14500									
6	20000	14500									
1 - 2	40000	30029									
1 - 3	48500	46221									
1 - 4	77500	60721									
1 - 5	84000	75221									
1 - 6	92000	89721									
2 - 3	34000	32385									
2 - 4	60000	46885									
2 - 5	72000	61385									
2 - 6	79000	75884									
3 - 4	40000	30692									
3 - 5	60000	45192									
3 - 6	72500	59692									
4 - 5	34000	29000									
4 - 6	43500	43500									

◀ = U.S. Bridge Formula Violation

Page 1 of 1

Conf. 5: 40’ Chassis with tridem axle spacing 98’’

5-1. 80,0000 lb GVW

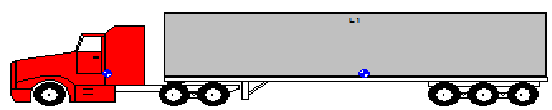


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10102	7512	6366	23980
Accessories:	0	0	0	0
Payload:	3051	20315	32654	56020
Total:	13152	27828	39020	80000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	13152		5 - 6	34000	26013								
2	20000	13914												
3	20000	13914												
4	20000	13007												
5	20000	13007												
6	20000	13007												
1 - 2	40000	27066												
1 - 3	48500	40980												
1 - 4	69500	53987												
1 - 5	76000	66993												
1 - 6	80000	80000												
2 - 3	34000	27828												
2 - 4	57000	40834												
2 - 5	63500	53841												
2 - 6	70500	66848												
3 - 4	40000	26921												
3 - 5	57000	39927												
3 - 6	63500	52934												
4 - 5	34000	26013												
4 - 6	42000	39020												

◄ = U.S. Bridge Formula Violation

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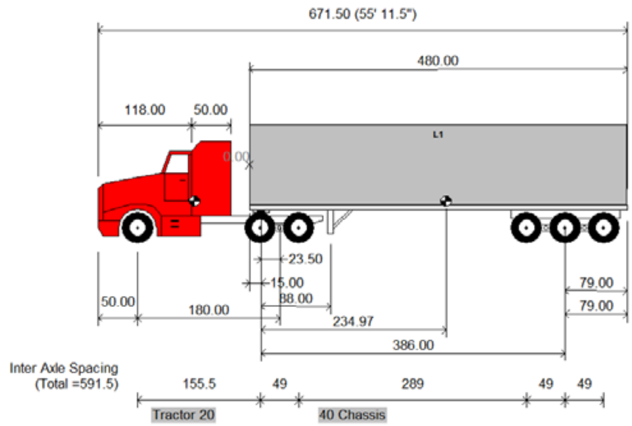
5-2. 97,000 lbs GVW

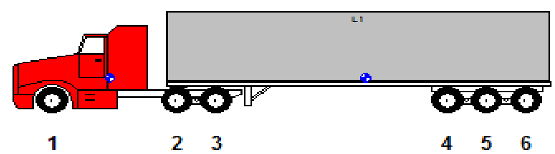


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10102	7512	6366	23980
Accessories:	0	0	0	0
Payload:	3976	26480	42563	73020
Total:	14078	33993	48929	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

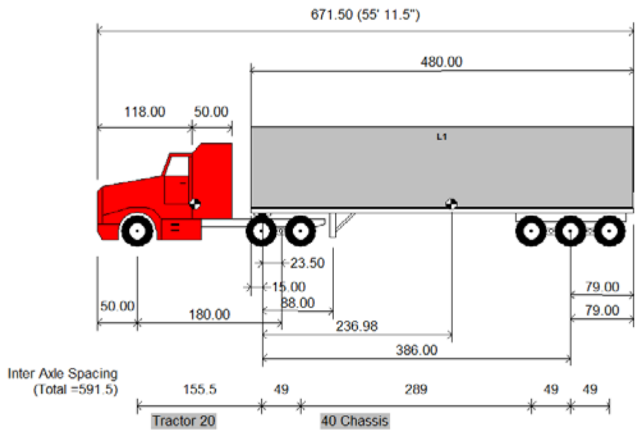
Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	14078		5 - 6	34000	32620									
2	20000	16996													
3	20000	16996													
4	20000	16310													
5	20000	16310													
6	20000	16310													
1 - 2	40000	31074													
1 - 3	48500	48071													
1 - 4	69500	64380													
1 - 5	76000	80690	◄												
1 - 6	80000	97000	◄												
2 - 3	34000	33993													
2 - 4	57000	50302													
2 - 5	63500	66612	◄												
2 - 6	70500	82922	◄												
3 - 4	40000	33306													
3 - 5	57000	49616													
3 - 6	63500	65926	◄												
4 - 5	34000	32620													
4 - 6	42000	48929	◄												

◄ = U.S. Bridge Formula Violation

Page 1 of 1

5-3. *Maximum Payload under U.S. Bridge Formula*



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10102	7512	6366	23980
Accessories:	0	0	0	0
Payload:	3241	21585	34694	59520
Total:	13343	29097	41060	83500
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

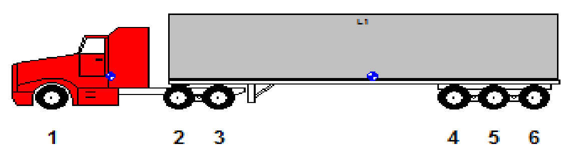
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

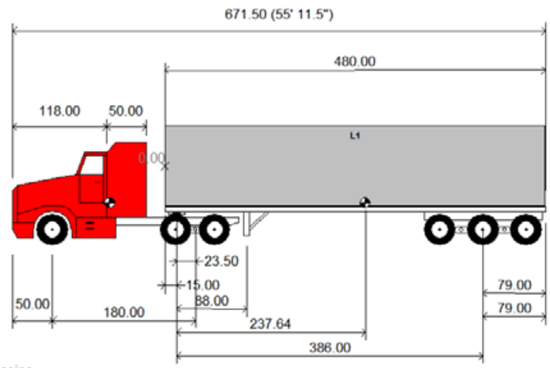


Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	13343	5 - 6	34000	27373						
2	20000	14548									
3	20000	14548									
4	20000	13687									
5	20000	13687									
6	20000	13687									
1 - 2	40000	27891									
1 - 3	48500	42440									
1 - 4	69500	56127									
1 - 5	76000	69813									
1 - 6	83500	83500									
2 - 3	34000	29097									
2 - 4	57000	42784									
2 - 5	63500	56470									
2 - 6	70500	70157									
3 - 4	40000	28235									
3 - 5	57000	41922									
3 - 6	63500	55609									
4 - 5	34000	27373									
4 - 6	42000	41060									

◄ = **U.S. Bridge Formula Violation** **Page 1 of 1**

Conf. 6: 40’ Chassis with tridem axle spacing 109’’

6-1.   80,000 lbs GVW



Inter Axle Spacing (Total =597)	155.5	49	283.5	54.5	54.5
	Tractor 20		40 Chassis		

Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10102	7512	6366	23980
Accessories:	0	0	0	0
Payload:	3051	20315	32654	56020
Total:	13152	27828	39020	80000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
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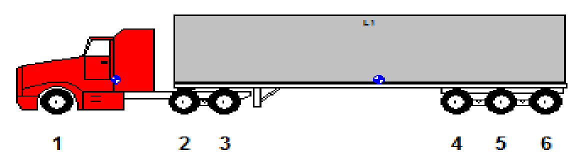
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb
1	20000	13152	5 - 6	34000	26013						
2	20000	13914									
3	20000	13914									
4	20000	13007									
5	20000	13007									
6	20000	13007									
1 - 2	40000	27066									
1 - 3	48500	40980									
1 - 4	69500	53987									
1 - 5	76000	66993									
1 - 6	80000	80000									
2 - 3	34000	27828									
2 - 4	57000	40834									
2 - 5	63500	53841									
2 - 6	71000	66848									
3 - 4	40000	26921									
3 - 5	57000	39927									
3 - 6	64000	52934									
4 - 5	34000	26013									
4 - 6	42500	39020									

◄ = U.S. Bridge Formula Violation

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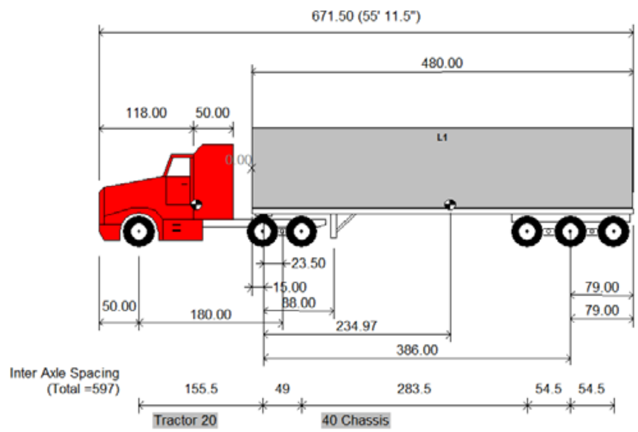
6-2. 97,000 lb GVW

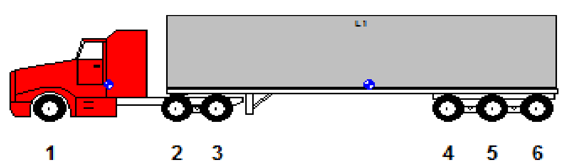


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10102	7512	6366	23980
Accessories:	0	0	0	0
Payload:	3976	26480	42563	73020
Total:	14078	33993	48929	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



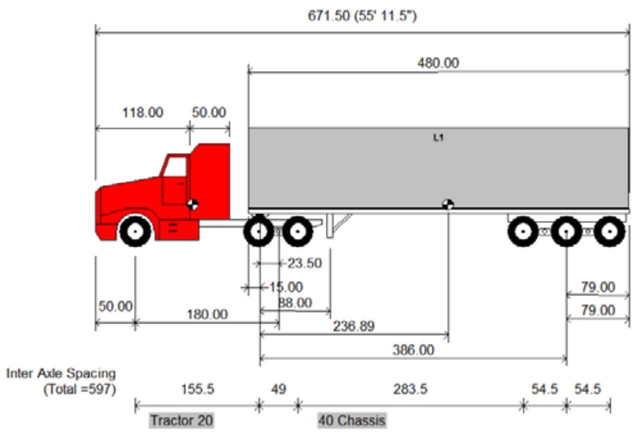
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	14078		5 - 6	34000	32620									
2	20000	16996													
3	20000	16996													
4	20000	16310													
5	20000	16310													
6	20000	16310													
1 - 2	40000	31074													
1 - 3	48500	48071													
1 - 4	69500	64380													
1 - 5	76000	80690	◄												
1 - 6	80000	97000	◄												
2 - 3	34000	33993													
2 - 4	57000	50302													
2 - 5	63500	66612	◄												
2 - 6	71000	82922	◄												
3 - 4	40000	33306													
3 - 5	57000	49616													
3 - 6	64000	65926	◄												
4 - 5	34000	32620													
4 - 6	42500	48929	◄												

◄ = U.S. Bridge Formula Violation **Page 1 of 1**

6-3. Maximum Payload under U.S. Bridge Formula

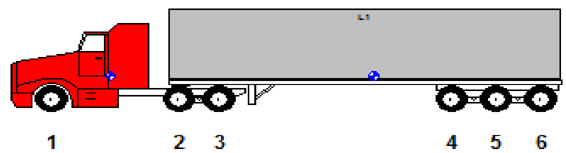


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10102	7512	6366	23980
Accessories:	0	0	0	0
Payload:	3268	21766	34986	60020
Total:	13370	29278	41352	84000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



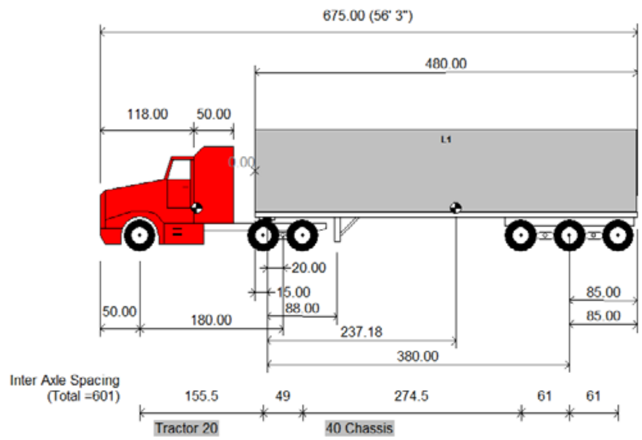
BRIDGE FORMULA OPTION:
- Maximum Gross Vehicle Weight: 97000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	llowabl.oad (lb	Current.oad (lb	Axle Bridge	llowabl.oad (lb	Current.oad (lb	Axle Bridge	llowabl.oad (lb	Current.oad (lb	Axle Bridge	llowabl.oad (lb	Current.oad (lb
1	20000	13370	5 - 6	34000	27568						
2	20000	14639									
3	20000	14639									
4	20000	13784									
5	20000	13784									
6	20000	13784									
1 - 2	40000	28009									
1 - 3	48500	42648									
1 - 4	69500	56432									
1 - 5	76000	70216									
1 - 6	84000	84000									
2 - 3	34000	29278									
2 - 4	57000	43062									
2 - 5	63500	56846									
2 - 6	71000	70630									
3 - 4	40000	28423									
3 - 5	57000	42207									
3 - 6	64000	55991									
4 - 5	34000	27568									
4 - 6	42500	41352									

◄ = **U.S. Bridge Formula Violation** **Page 1 of 1**

Conf. 7: 40’ Chassis with tridem axle spacing 122’’

7-1. 80,0000 lb GVW

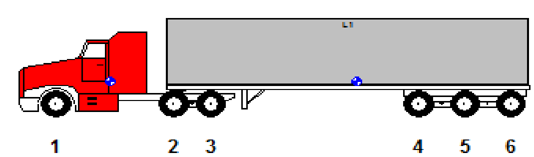


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10080	7511	6390	23980
Accessories:	0	0	0	0
Payload:	2539	20311	33170	56020
Total:	12619	27822	39559	80000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb	
1	20000	12619		5 - 6	34000	26373									
2	20000	13911													
3	20000	13911													
4	20000	13186													
5	20000	13186													
6	20000	13186													
1 - 2	40000	26530													
1 - 3	48500	40441													
1 - 4	68500	53627													
1 - 5	76000	66814													
1 - 6	80000	80000													
2 - 3	34000	27822													
2 - 4	56000	41008													
2 - 5	63500	54195													
2 - 6	71000	67381													
3 - 4	40000	27097													
3 - 5	57000	40284													
3 - 6	64000	53470													
4 - 5	34000	26373													
4 - 6	43500	39559													

◀ = U.S. Bridge Formula Violation

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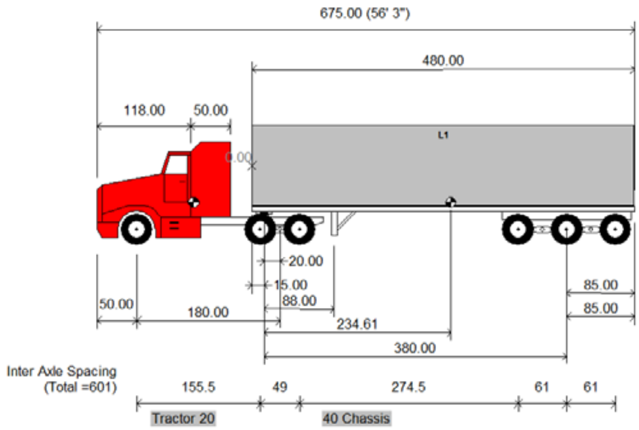
7-2. 97,0000 lb GVW

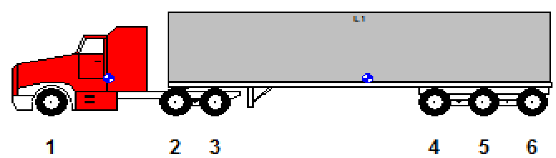


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10080	7511	6390	23980
Accessories:	0	0	0	0
Payload:	3309	26475	43236	73020
Total:	13389	33986	49625	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	13389		5 - 6	34000	33083									
2	20000	16993													
3	20000	16993													
4	20000	16542													
5	20000	16542													
6	20000	16542													
1 - 2	40000	30382													
1 - 3	48500	47375													
1 - 4	68500	63917													
1 - 5	76000	80458	◄												
1 - 6	80000	97000	◄												
2 - 3	34000	33986													
2 - 4	56000	50527													
2 - 5	63500	67069	◄												
2 - 6	71000	83611	◄												
3 - 4	40000	33535													
3 - 5	57000	50076													
3 - 6	64000	66618	◄												
4 - 5	34000	33083													
4 - 6	43500	49625	◄												

◄ = U.S. Bridge Formula Violation

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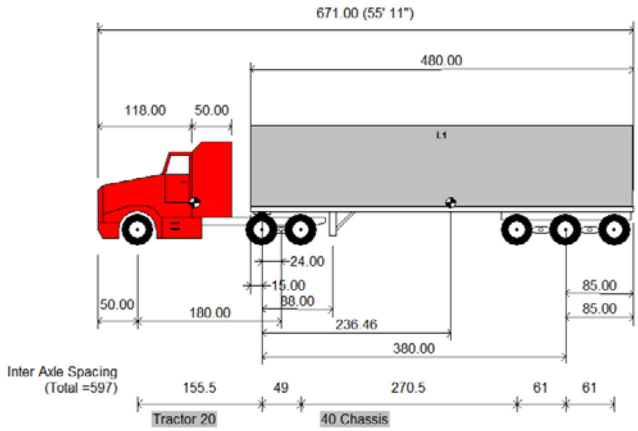
7-3. Maximum Payload under U.S. Bridge Formula



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10101	7489	6390	23980
Accessories:	0	0	0	0
Payload:	3264	21218	35538	60020
Total:	13366	28707	41928	84000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

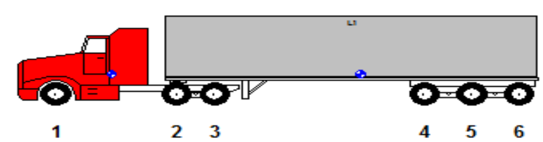
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

BRIDGE FORMULA OPTION:

- Maximum Gross Vehicle Weight: 97000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot



Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb
1	20000	13366	5 - 6	34000	27952						
2	20000	14353									
3	20000	14353									
4	20000	13976									
5	20000	13976									
6	20000	13976									
1 - 2	40000	27719									
1 - 3	48500	42072									
1 - 4	68500	56048									
1 - 5	76000	70024									
1 - 6	84000	84000									
2 - 3	34000	28707									
2 - 4	56000	42683									
2 - 5	63500	56658									
2 - 6	71000	70634									
3 - 4	40000	28329									
3 - 5	57000	42305									
3 - 6	64000	56281									
4 - 5	34000	27952									
4 - 6	43500	41928									

◄ = U.S. Bridge Formula Violation

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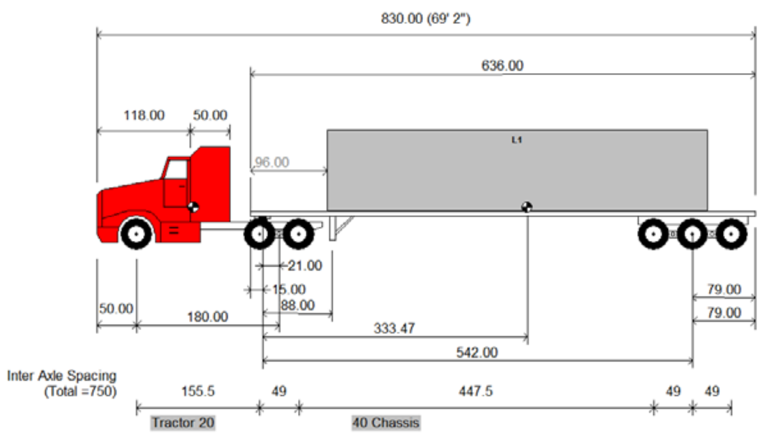
Conf. 8: 53’ Chassis with tridem axle spacing 98’’

8-1. 97,0000 lb GVW

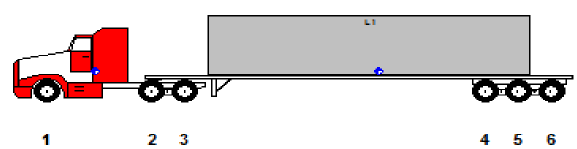


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10313	9229	8778	28320
Accessories:	0	0	0	0
Payload:	3267	24737	40676	68680
Total:	13580	33966	49454	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	13580		5 - 6	34000	32970									
2	20000	16983													
3	20000	16983													
4	20000	16485													
5	20000	16485													
6	20000	16485													
1 - 2	40000	30563													
1 - 3	48500	47546													
1 - 4	78000	64030													
1 - 5	80000	80515	◄												
1 - 6	80000	97000	◄												
2 - 3	34000	33966													
2 - 4	60000	50450													
2 - 5	72000	66935													
2 - 6	79000	83420	◄												
3 - 4	40000	33468													
3 - 5	60000	49952													
3 - 6	72000	66437													
4 - 5	34000	32970													
4 - 6	42000	49454	◄												

◄ = U.S. Bridge Formula Violation

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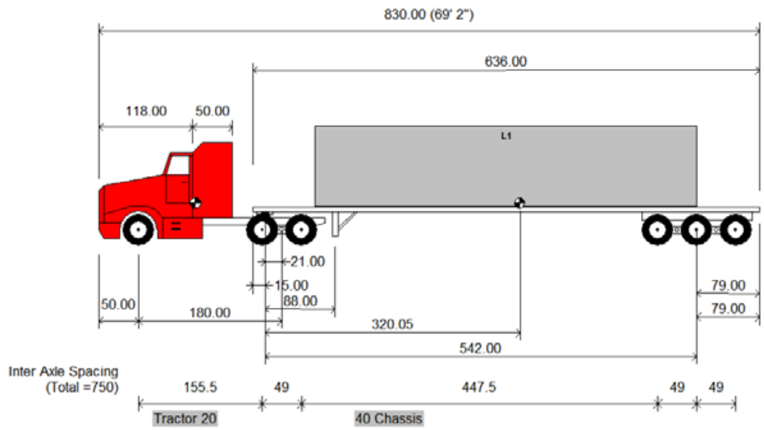
8-2. *Maximum Payload under U.S. Bridge Formula*

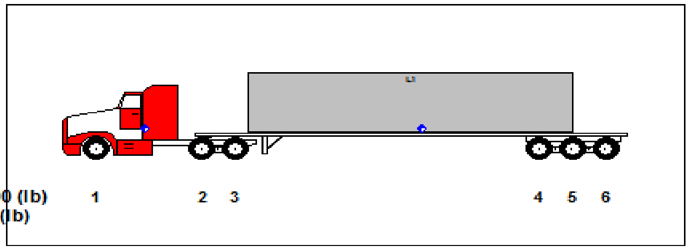


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10313	9229	8778	28320
Accessories:	0	0	0	0
Payload:	3057	23147	33221	59425
Total:	13370	32376	41999	87745
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

- Maximum Gross Vehicle Weight: 97000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb
1	20000	13370	5 - 6	34000	28000						
2	20000	16188									
3	20000	16188									
4	20000	14000									
5	20000	14000									
6	20000	14000									
1 - 2	40000	29558									
1 - 3	48500	45746									
1 - 4	78000	59745									
1 - 5	84000	73745									
1 - 6	92000	87745									
2 - 3	34000	32376									
2 - 4	60000	46375									
2 - 5	72000	60375									
2 - 6	79000	74375									
3 - 4	40000	30188									
3 - 5	60000	44187									
3 - 6	72000	58187									
4 - 5	34000	28000									
4 - 6	42000	41999									

◀ = U.S. Bridge Formula Violation

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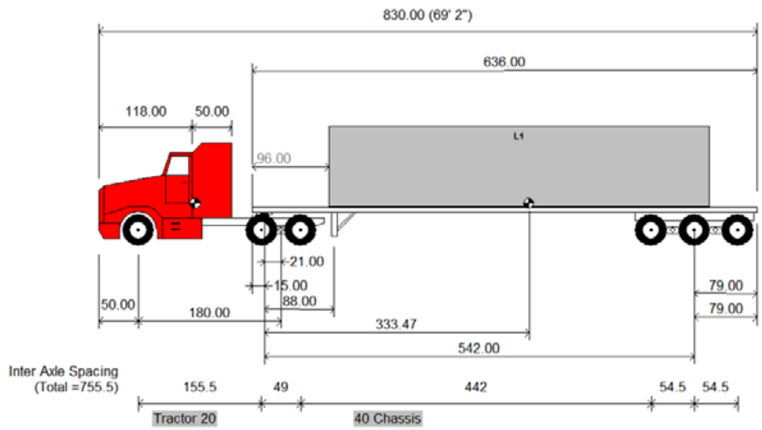
Conf. 9: 53’ Chassis with tridem axle spacing 109’’

9-1. 97,0000 lb GVW

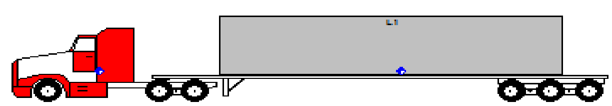


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10313	9229	8778	28320
Accessories:	0	0	0	0
Payload:	3267	24737	40676	68680
Total:	13580	33966	49454	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb		Axle Bridge	llowabl Load (lb	Current Load (lb
1	20000	13580		5 - 6	34000	32970								
2	20000	16983												
3	20000	16983												
4	20000	16485												
5	20000	16485												
6	20000	16485												
1 - 2	40000	30563												
1 - 3	48500	47546												
1 - 4	78000	64030												
1 - 5	80000	80515	◀											
1 - 6	80000	97000	◀											
2 - 3	34000	33966												
2 - 4	60000	50450												
2 - 5	72000	66935												
2 - 6	79000	83420	◀											
3 - 4	40000	33468												
3 - 5	60000	49952												
3 - 6	72500	66437												
4 - 5	34000	32970												
4 - 6	42500	49454	◀											

◀ = U.S. Bridge Formula Violation

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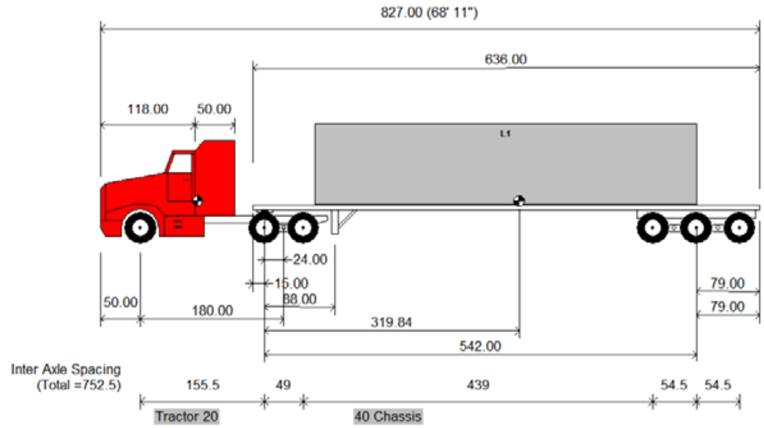
9-2. Maximum Payload under U.S. Bridge Formula

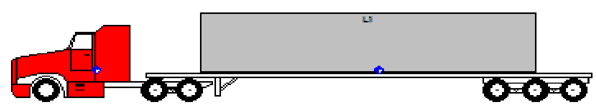


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10362	9180	8778	28320
Accessories:	0	0	0	0
Payload:	3546	23052	33721	60320
Total:	13908	32232	42500	88640
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	13908	5 - 6	34000	28333						
2	20000	16116									
3	20000	16116									
4	20000	14167									
5	20000	14167									
6	20000	14167									
1 - 2	40000	30024									
1 - 3	48500	46140									
1 - 4	78000	60307									
1 - 5	84000	74473									
1 - 6	92000	88640									
2 - 3	34000	32232									
2 - 4	60000	46399									
2 - 5	72000	60565									
2 - 6	79000	74732									
3 - 4	40000	30283									
3 - 5	60000	44449									
3 - 6	72500	58616									
4 - 5	34000	28333									
4 - 6	42500	42500									

◄ = U.S. Bridge Formula Violation

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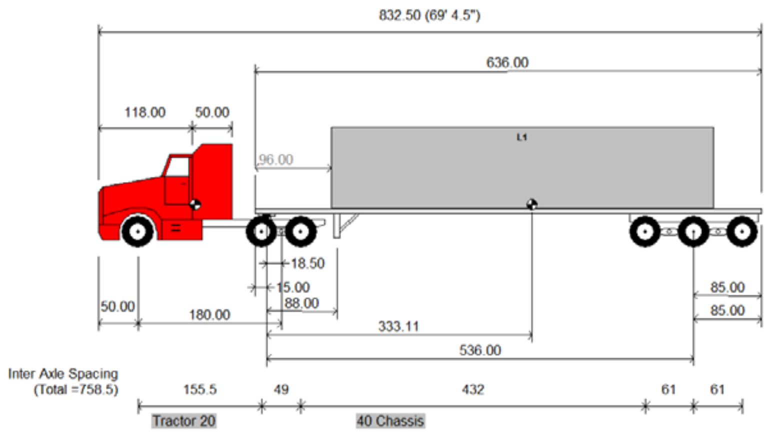
Conf. 10: 53’ Chassis with tridem axle spacing 122’’

10-1. 97,0000 lb GVW

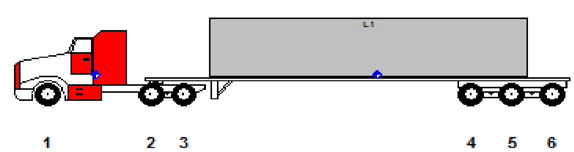


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10268	9230	8822	28320
Accessories:	0	0	0	0
Payload:	2831	24717	41131	68680
Total:	13099	33947	49953	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	13099		5 - 6	34000	33302									
2	20000	16974													
3	20000	16974													
4	20000	16651													
5	20000	16651													
6	20000	16651													
1 - 2	40000	30073													
1 - 3	48500	47047													
1 - 4	77500	63698													
1 - 5	80000	80349	◀												
1 - 6	80000	97000	◀												
2 - 3	34000	33947													
2 - 4	60000	50599													
2 - 5	72000	67250													
2 - 6	79000	83901	◀												
3 - 4	40000	33625													
3 - 5	60000	50276													
3 - 6	72500	66927													
4 - 5	34000	33302													
4 - 6	43500	49953	◀												

◀ = U.S. Bridge Formula Violation

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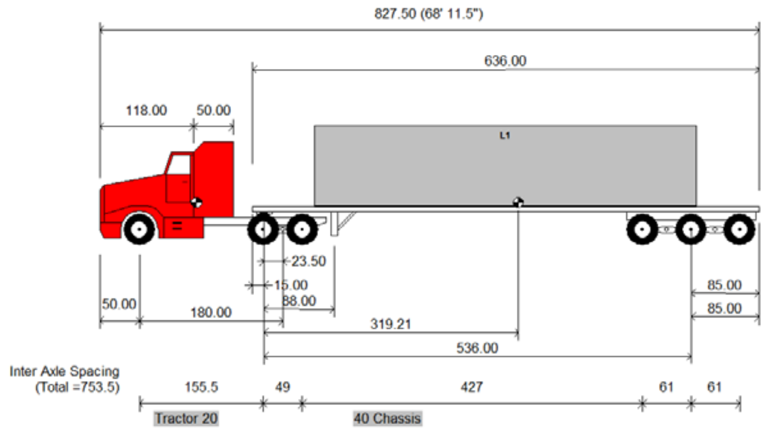
10-2. Maximum Payload under U.S. Bridge Formula

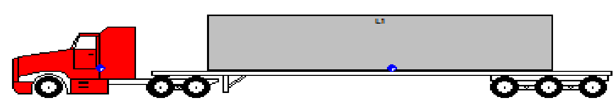


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10348	9150	8822	28320
Accessories:	0	0	0	0
Payload:	3481	23185	34677	61343
Total:	13829	32334	43499	89663
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



1 2 3 4 5 6

BRIDGE FORMULA OPTION:

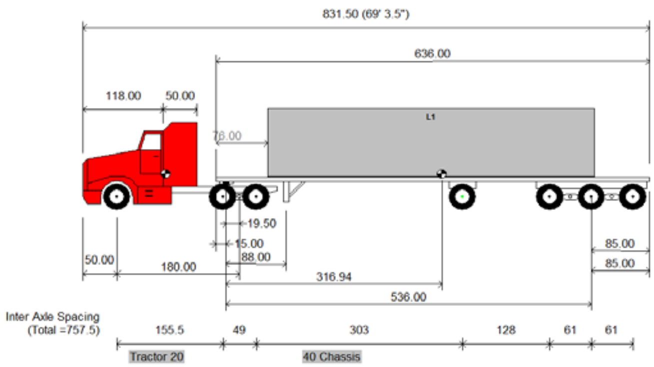
Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	13829		5 - 6	34000	29000								
2	20000	16167												
3	20000	16167												
4	20000	14500												
5	20000	14500												
6	20000	14500												
1 - 2	40000	29996												
1 - 3	48500	46164												
1 - 4	77500	60663												
1 - 5	84000	75163												
1 - 6	92000	89663												
2 - 3	34000	32334												
2 - 4	60000	46834												
2 - 5	72000	61334												
2 - 6	79000	75834												
3 - 4	40000	30667												
3 - 5	60000	45167												
3 - 6	72500	59667												
4 - 5	34000	29000												
4 - 6	43500	43499												

◄ **= U.S. Bridge Formula Violation** **Page 1 of 1**

Conf. 11: 53' Chassis with tridem axle spacing 122'' liftable axle-6250 lbs

11-1. 97,0000 lb GVW

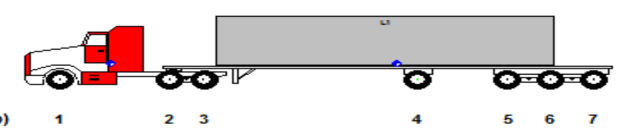


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	#4 (lb)	Total (lb)
Tare:	10346	9723	0	9871	29940
Accessories:	0	0	0	0	0
Payload:	2946	24251	6250	33613	67060
Total:	13292	33974	6250	43484	97000
Desired/(GVW)*:	U.S. Bridge Formula				-
GAWR/(GVWR*):	-	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl.oad (lb	Current.oad (lb		Axle Bridge	llowabl.oad (lb	Current.oad (lb		Axle Bridge	llowabl.oad (lb	Current.oad (lb		Axle Bridge	llowabl.oad (lb	Current.oad (lb	
1	20000	13292		3 - 6	69500	52226									
2	20000	16987		3 - 7	76500	66721									
3	20000	16987		4 - 5	40000	20745									
4	20000	6250		4 - 6	48000	35239									
5	20000	14495		4 - 7	56000	49734									
6	20000	14495		5 - 6	34000	28989									
7	20000	14495		5 - 7	43500	43484									
1 - 2	40000	30279		6 - 7	34000	28989									
1 - 3	48500	47266													
1 - 4	70000	53516													
1 - 5	80000	68011													
1 - 6	80000	82505	◄												
1 - 7	80000	97000	◄												
2 - 3	34000	33974													
2 - 4	57500	40224													
2 - 5	68500	54719													
2 - 6	76000	69213													
2 - 7	80000	83708	◄												
3 - 4	40000	23237													
3 - 5	60000	37732													

◄ = U.S. Bridge Formula Violation

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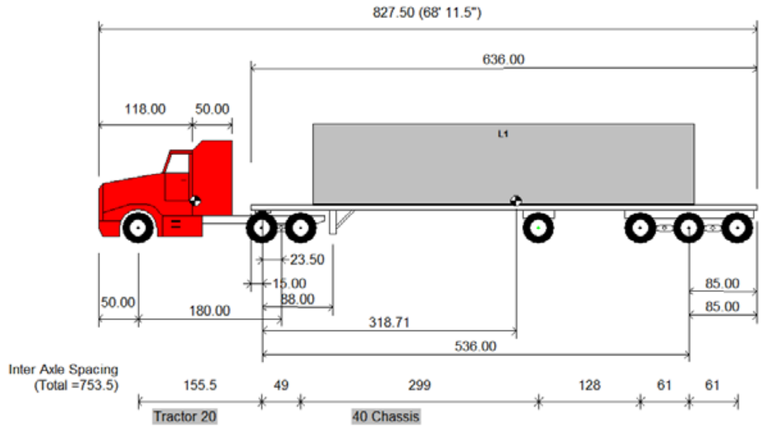
11-2. Maximum Payload under U.S. Bridge Formula



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	#4 (lb)	Total (lb)
Tare:	10422	9647	0	9871	29940
Accessories:	0	0	0	0	0
Payload:	3490	23240	6250	33580	66560
Total:	13912	32887	6250	43451	96500
Desired/(GVW)*:	U.S. Bridge Formula				-
GAWR/(GVWR*):	-	-	-	-	-

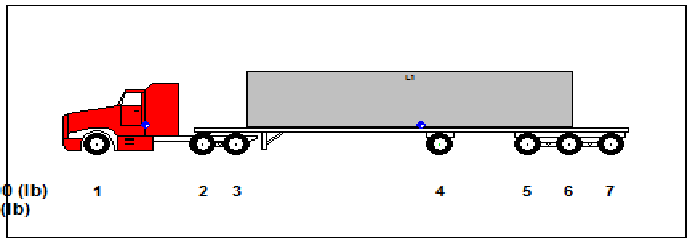
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	13912	3 - 6	69500	51661						
2	20000	16443	3 - 7	76500	66145						
3	20000	16443	4 - 5	40000	20734						
4	20000	6250	4 - 6	48000	35217						
5	20000	14484	4 - 7	56000	49701						
6	20000	14484	5 - 6	34000	28967						
7	20000	14484	5 - 7	43500	43451						
1 - 2	40000	30355	6 - 7	34000	28967						
1 - 3	48500	46799									
1 - 4	70000	53049									
1 - 5	81000	67533									
1 - 6	89000	82016									
1 - 7	96500	96500									
2 - 3	34000	32887									
2 - 4	57500	39137									
2 - 5	68500	53621									
2 - 6	76000	68104									
2 - 7	84000	82588									
3 - 4	40000	22693									
3 - 5	60000	37177									

◀ = U.S. Bridge Formula Violation

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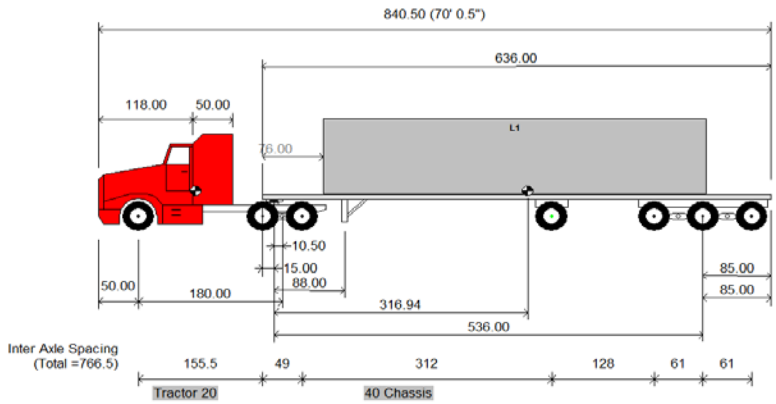
Conf. 12: 53’ Chassis with tridem axle spacing 122’’ liftable axle-11,000 lbs

12-1. 97,0000 lb GVW

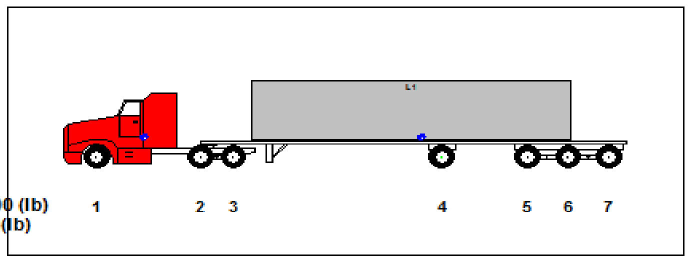


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	#4 (lb)	Total (lb)
Tare:	10173	9896	0	9871	29940
Accessories:	0	0	0	0	0
Payload:	1489	24034	11000	30537	67060
Total:	11662	33929	11000	40409	97000
Desired/(GVW)*:	U.S. Bridge Formula				-
GAWR/(GVWR*):	-	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	11662		3 - 6	70000	54904									
2	20000	16965		3 - 7	77500	68373									
3	20000	16965		4 - 5	40000	24470									
4	20000	11000		4 - 6	48000	37939									
5	20000	13470		4 - 7	56000	51409									
6	20000	13470		5 - 6	34000	26939									
7	20000	13470		5 - 7	43500	40409									
1 - 2	40000	28627		6 - 7	34000	26939									
1 - 3	48500	45591													
1 - 4	70500	56591													
1 - 5	80000	70061													
1 - 6	80000	83530	◄												
1 - 7	80000	97000	◄												
2 - 3	34000	33929													
2 - 4	58500	44929													
2 - 5	69500	58399													
2 - 6	76500	71868													
2 - 7	80000	85338	◄												
3 - 4	40000	27965													
3 - 5	60000	41434													

◄ = U.S. Bridge Formula Violation

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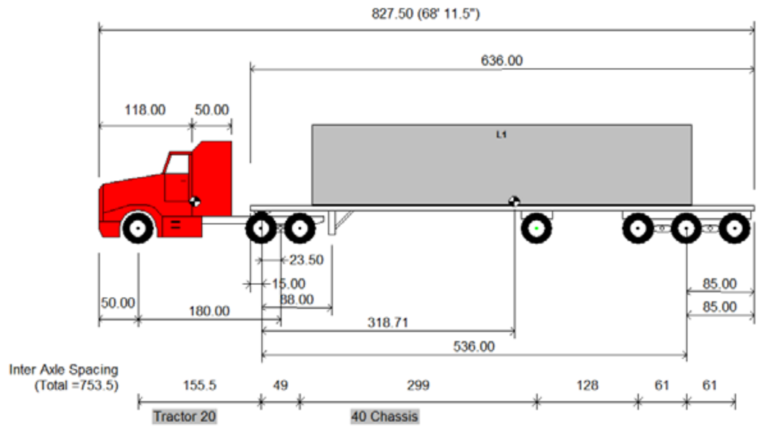
12-2. Maximum Payload under U.S. Bridge Formula

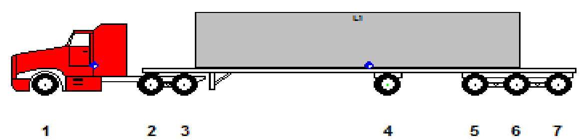


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	#4 (lb)	Total (lb)
Tare:	10422	9647	0	9871	29940
Accessories:	0	0	0	0	0
Payload:	3271	21784	11000	30505	66560
Total:	13693	31431	11000	40376	96500
Desired/(GVW)*:	U.S. Bridge Formula				-
GAWR/(GVWR*):	-	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb
1	20000	13693	3 - 6	69500	53633						
2	20000	15715	3 - 7	76500	67091						
3	20000	15715	4 - 5	40000	24459						
4	20000	11000	4 - 6	48000	37917						
5	20000	13459	4 - 7	56000	51376						
6	20000	13459	5 - 6	34000	26917						
7	20000	13459	5 - 7	43500	40376						
1 - 2	40000	29409	6 - 7	34000	26917						
1 - 3	48500	45124									
1 - 4	70000	56124									
1 - 5	81000	69583									
1 - 6	89000	83041									
1 - 7	96500	96500									
2 - 3	34000	31431									
2 - 4	57500	42431									
2 - 5	68500	55889									
2 - 6	76000	69348									
2 - 7	84000	82807									
3 - 4	40000	26715									
3 - 5	60000	40174									

◄ = U.S. Bridge Formula Violation

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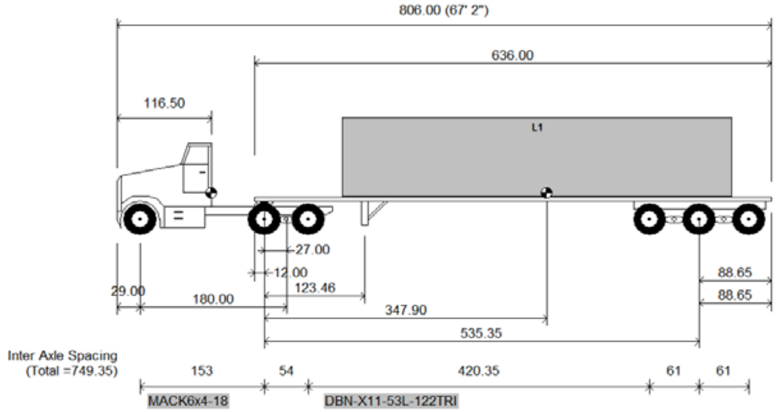
Conf. 21: Mack Granite 6x4 axle forward Tractor, tandem axle, 180" wheel base; 53' Dionbilt X11 fixed 122’’ tridem axle chassis (no liftable axles)

21-1. 80,000 lb GVW

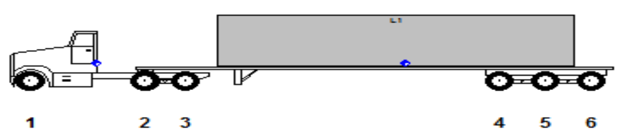


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8714	10887	9895	29496
Accessories:	0	0	0	0
Payload:	2821	15986	31697	50504
Total:	11535	26873	41593	80000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb)	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb)	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	11535	5 - 6	34000	27729						
2	20000	13436									
3	20000	13436									
4	20000	13864									
5	20000	13864									
6	20000	13864									
1 - 2	40000	24971									
1 - 3	48500	38407									
1 - 4	76500	52272									
1 - 5	83500	66136									
1 - 6	91000	80000									
2 - 3	34000	26873									
2 - 4	60000	40737									
2 - 5	72000	54601									
2 - 6	79000	68465									
3 - 4	40000	27301									
3 - 5	60000	41165									
3 - 6	72000	55029									
4 - 5	34000	27729									
4 - 6	43500	41593									

◄ = U.S. Bridge Formula Violation

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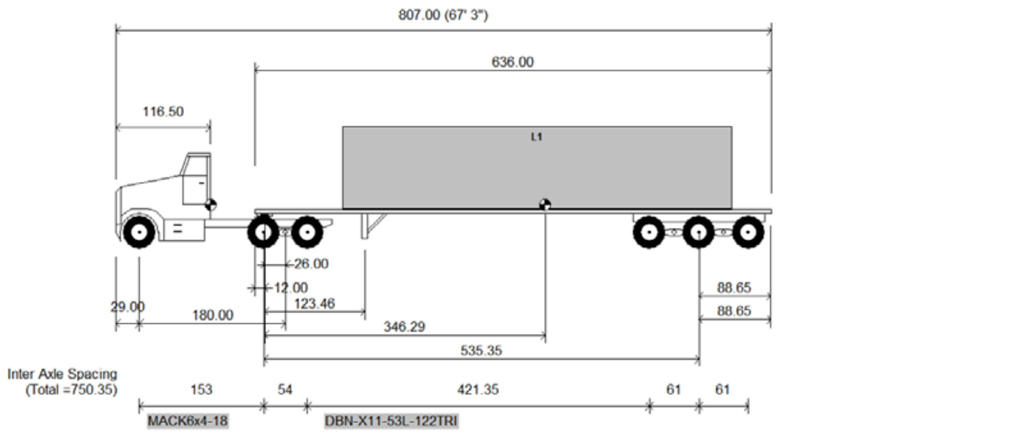
21-2. 90,000 lb GVW



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8694	10907	9895	29496
Accessories:	0	0	0	0
Payload:	3254	19276	37974	60504
Total:	11948	30183	47869	90000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
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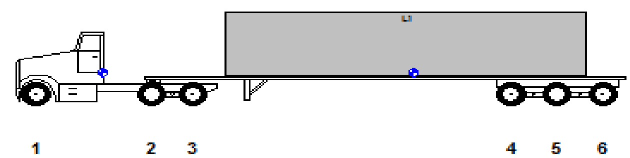

BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	11948		5 - 6	34000	31913									
2	20000	15091													
3	20000	15091													
4	20000	15956													
5	20000	15956													
6	20000	15956													
1 - 2	40000	27040													
1 - 3	48500	42131													
1 - 4	76500	58087													
1 - 5	83500	74044													
1 - 6	92000	90000													
2 - 3	34000	30183													
2 - 4	60000	46139													
2 - 5	72000	62096													
2 - 6	79000	78052													
3 - 4	40000	31048													
3 - 5	60000	47004													
3 - 6	72000	62960													
4 - 5	34000	31913													
4 - 6	43500	47869	◀												

◀ = U.S. Bridge Formula Violation

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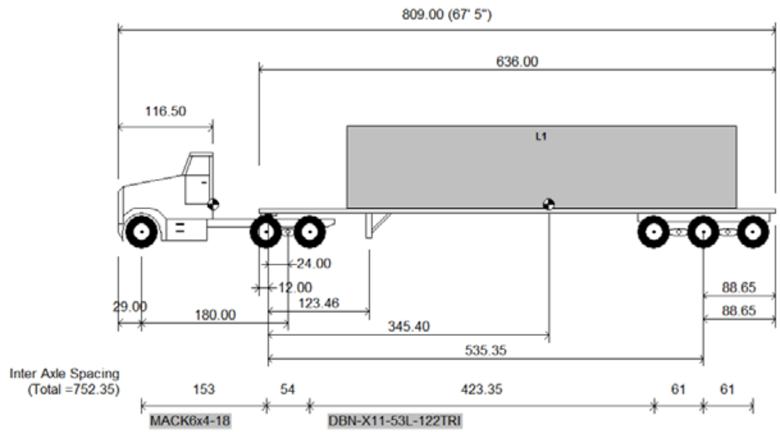
21-3. 97,000 lb GVW



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8654	10947	9895	29496
Accessories:	0	0	0	0
Payload:	3352	21785	42367	67504
Total:	12005	32732	52262	97000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
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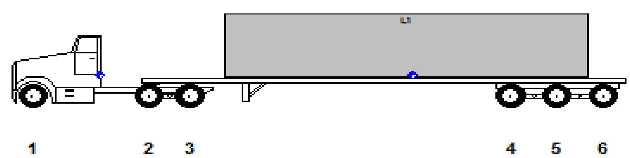


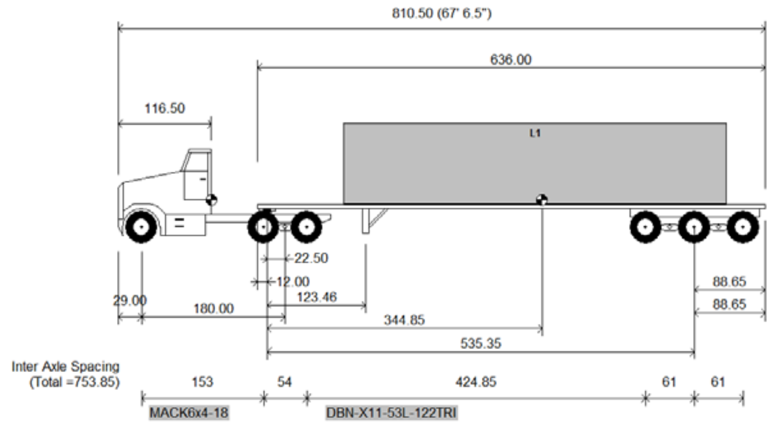
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb)		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	12005		5 - 6	34000	34842	◄								
2	20000	16366													
3	20000	16366													
4	20000	17421													
5	20000	17421													
6	20000	17421													
1 - 2	40000	28371													
1 - 3	48500	44738													
1 - 4	77500	62158													
1 - 5	84000	79579													
1 - 6	92000	97000	◄												
2 - 3	34000	32732													
2 - 4	60000	50153													
2 - 5	72000	67574													
2 - 6	79000	84995	◄												
3 - 4	40000	33787													
3 - 5	60000	51208													
3 - 6	72000	68629													
4 - 5	34000	34842	◄												
4 - 6	43500	52262	◄												

◄ = U.S. Bridge Formula Violation **Page 1 of 1**

21-4. 102,000 lb GVW

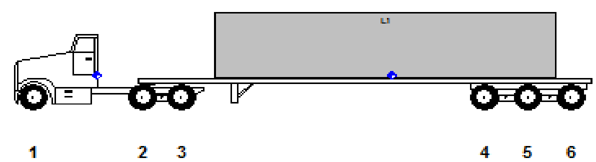


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8624	10977	9895	29496
Accessories:	0	0	0	0
Payload:	3375	23624	45505	72504
Total:	11998	34601	55400	102000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

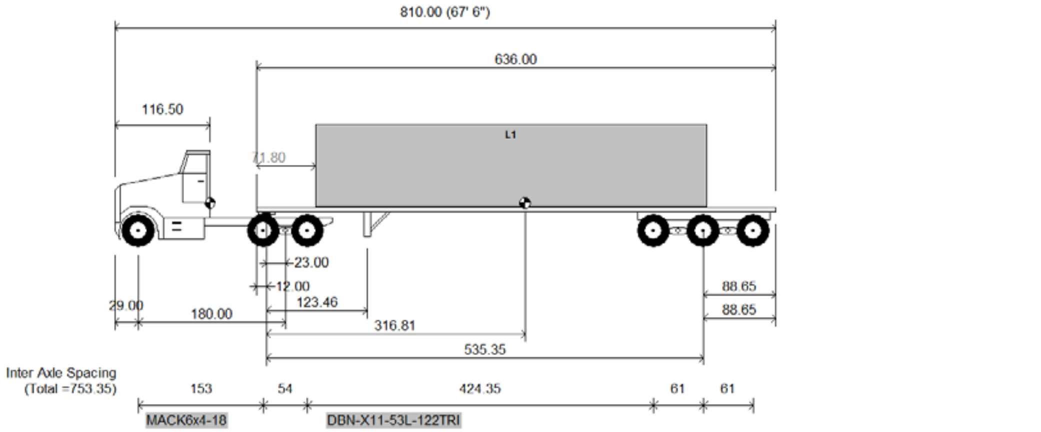


BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb)		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	11998		5 - 6	34000	36934	◄								
2	20000	17301													
3	20000	17301													
4	20000	18467													
5	20000	18467													
6	20000	18467													
1 - 2	40000	29299													
1 - 3	48500	46600													
1 - 4	77500	65066													
1 - 5	84000	83533													
1 - 6	92000	102000	◄												
2 - 3	34000	34601	◄												
2 - 4	60000	53068													
2 - 5	72000	71535													
2 - 6	79000	90002	◄												
3 - 4	40000	35767													
3 - 5	60000	54234													
3 - 6	72500	72701	◄												
4 - 5	34000	36934	◄												
4 - 6	43500	55400	◄												

21-5. Maximum Payload under U.S Bridge Formula (need move container)

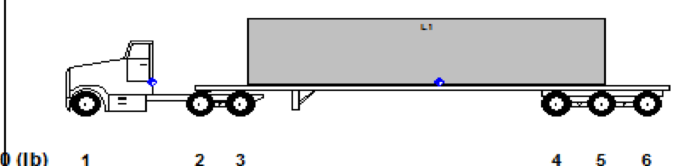


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8634	10967	9895	29496
Accessories:	0	0	0	0
Payload:	3374	23030	33605	60008
Total:	12007	33997	43500	89504
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



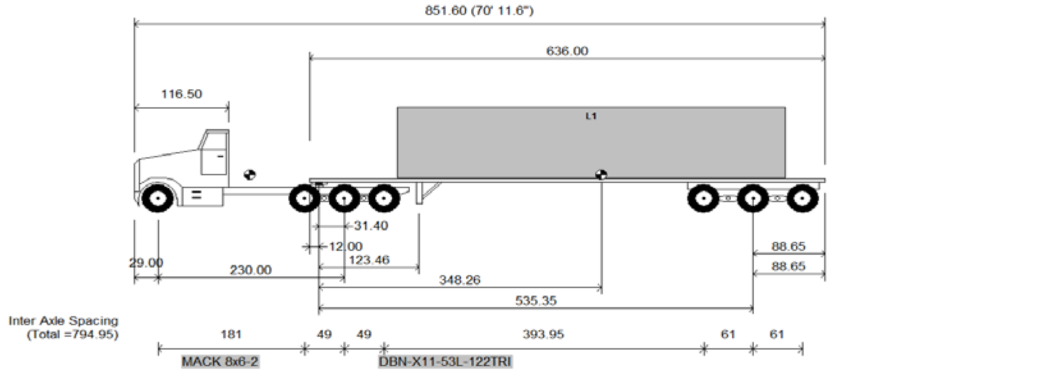
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb)	Current .oad (lb		Axle Bridge	llowabl .oad (lb)	Current .oad (lb)		Axle Bridge	llowabl .oad (lb)	Current .oad (lb		Axle Bridge	llowabl .oad (lb)	Current .oad (lb	
1	20000	12007		5 - 6	34000	29000									
2	20000	16998													
3	20000	16998													
4	20000	14500													
5	20000	14500													
6	20000	14500													
1 - 2	40000	29006													
1 - 3	48500	46004													
1 - 4	77500	60504													
1 - 5	84000	75004													
1 - 6	92000	89504													
2 - 3	34000	33997													
2 - 4	60000	48497													
2 - 5	72000	62997													
2 - 6	79000	77497													
3 - 4	40000	31498													
3 - 5	60000	45998													
3 - 6	72500	60498													
4 - 5	34000	29000													
4 - 6	43500	43500													

Conf. 22: Mack Granite 8x6 axle forward Tractor, tridem axle, 230" wheel base; 53' Dionbilt X11 fixed 122’’ tridem axle chassis (no lift axles)

22-1. 80,000 lb GVW

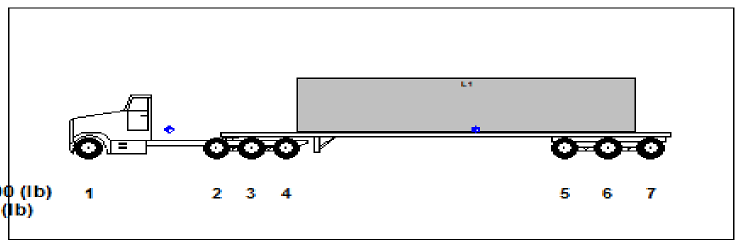


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9535	11975	9895	31406
Accessories:	0	0	0	0
Payload:	2470	15625	30499	48594
Total:	12006	27600	40394	80000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

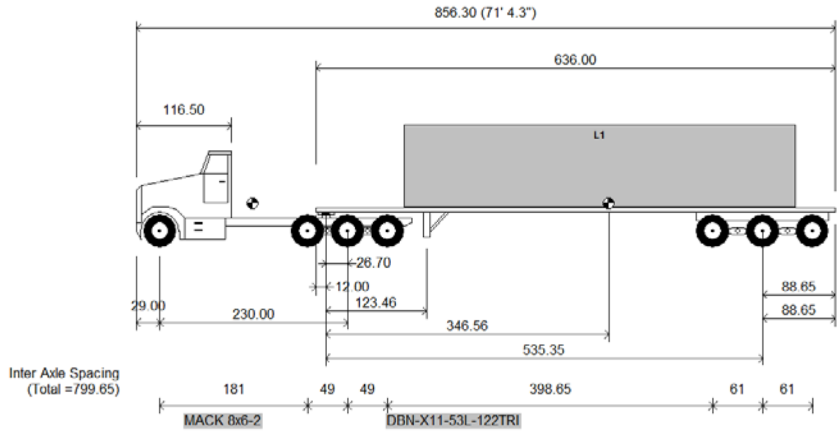


BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb)	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	12006	3 - 6	70000	45330						
2	20000	9200	3 - 7	77500	58794						
3	20000	9200	4 - 5	40000	22665						
4	20000	9200	4 - 6	60000	36129						
5	20000	13465	4 - 7	70500	49594						
6	20000	13465	5 - 6	34000	26929						
7	20000	13465	5 - 7	43500	40394						
1 - 2	40000	21206	6 - 7	34000	26929						
1 - 3	50000	30406									
1 - 4	57500	39606									
1 - 5	83000	53071									
1 - 6	90500	66535									
1 - 7	97000	80000									
2 - 3	34000	18400									
2 - 4	42000	27600									
2 - 5	69500	41065									
2 - 6	76500	54530									
2 - 7	84500	67994									
3 - 4	34000	18400									
3 - 5	60000	31865									

22-2. 90,000 lb GVW



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9462	12049	9895	31406
Accessories:	0	0	0	0
Payload:	2533	19286	36775	58594
Total:	11995	31335	46670	90000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

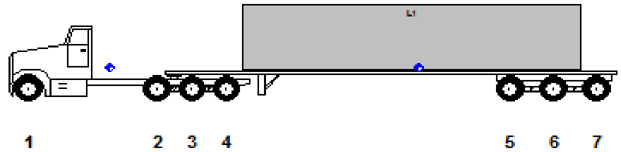
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

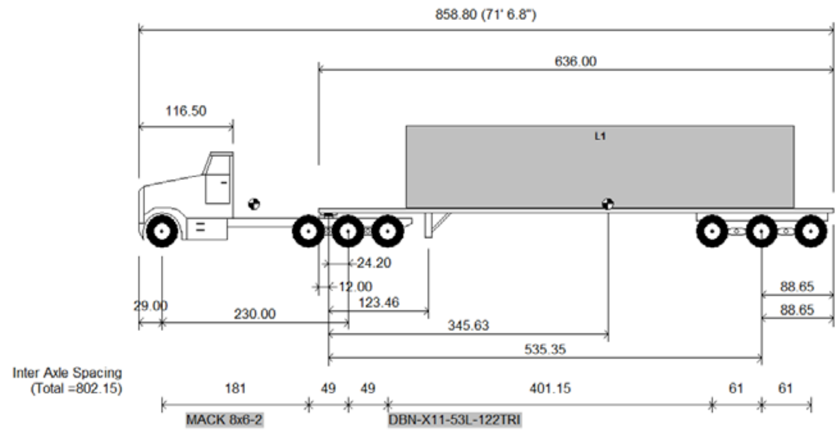
BRIDGE FORMULA OPTION:

- Maximum Gross Vehicle Weight: 97000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot



Axle Bridge	llowabl .oad (lb)	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb)		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	11995		3 - 6	70000	52004									
2	20000	10445		3 - 7	77500	67560									
3	20000	10445		4 - 5	40000	26002									
4	20000	10445		4 - 6	60000	41559									
5	20000	15557		4 - 7	70500	57115									
6	20000	15557		5 - 6	34000	31113									
7	20000	15557		5 - 7	43500	46670	◀								
1 - 2	40000	22440		6 - 7	34000	31113									
1 - 3	50000	32885													
1 - 4	57500	43330													
1 - 5	83000	58887													
1 - 6	91000	74443													
1 - 7	97000	90000													
2 - 3	34000	20890													
2 - 4	42000	31335													
2 - 5	69500	46892													
2 - 6	76500	62449													
2 - 7	85000	78005													
3 - 4	34000	20890													
3 - 5	60000	36447													

22-3. 97,000 lb GVW



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9422	12088	9895	31406
Accessories:	0	0	0	0
Payload:	2570	21856	41168	65594
Total:	11993	33944	51064	97000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

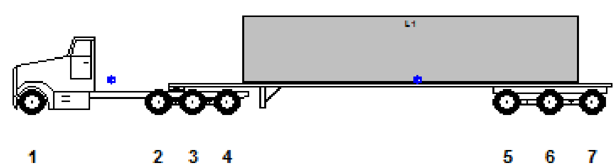
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

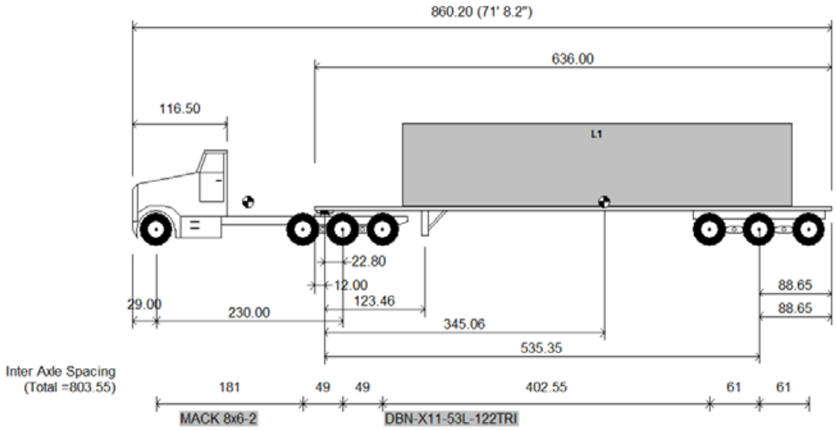
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb)		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	11993		3 - 6	70500	56672									
2	20000	11315		3 - 7	78000	73693									
3	20000	11315		4 - 5	40000	28336									
4	20000	11315		4 - 6	60000	45357									
5	20000	17021		4 - 7	71500	62378									
6	20000	17021		5 - 6	34000	34042	◀								
7	20000	17021		5 - 7	43500	51064	◀								
1 - 2	40000	23307		6 - 7	34000	34042	◀								
1 - 3	50000	34622													
1 - 4	57500	45936													
1 - 5	83500	62958													
1 - 6	91000	79979													
1 - 7	97000	97000													
2 - 3	34000	22629													
2 - 4	42000	33944													
2 - 5	70000	50965													
2 - 6	77500	67986													
2 - 7	85000	85007	◀												
3 - 4	34000	22629													
3 - 5	60000	39650													

22-4. 102,000 lb GVW



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9401	12110	9895	31406
Accessories:	0	0	0	0
Payload:	2606	23682	44306	70594
Total:	12006	35792	54202	102000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

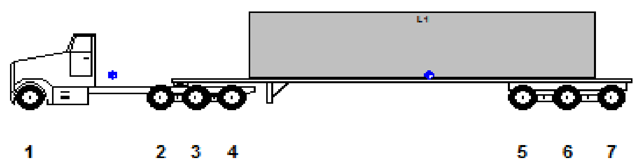
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

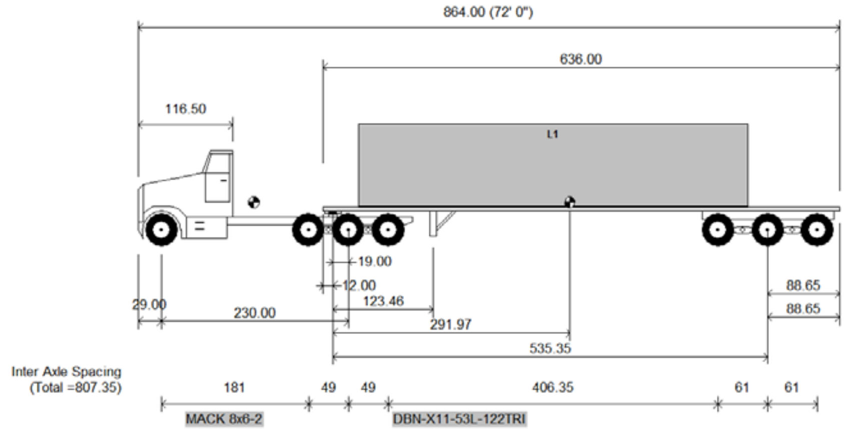
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb)		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	12006		3 - 6	70500	59996									
2	20000	11931		3 - 7	78000	78063	◀								
3	20000	11931		4 - 5	40000	29998									
4	20000	11931		4 - 6	60000	48065									
5	20000	18067		4 - 7	71500	66132									
6	20000	18067		5 - 6	34000	36134	◀								
7	20000	18067		5 - 7	43500	54202	◀								
1 - 2	40000	23937		6 - 7	34000	36134	◀								
1 - 3	50000	35868													
1 - 4	57500	47798													
1 - 5	83500	65866													
1 - 6	91000	83933													
1 - 7	97000	102000	◀												
2 - 3	34000	23861													
2 - 4	42000	35792													
2 - 5	70000	53859													
2 - 6	77500	71926													
2 - 7	85000	89994	◀												
3 - 4	34000	23861													
3 - 5	60000	41928													

22-5. Maximum Payload under U.S Bridge Formula (need move container)



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9341	12170	9895	31406
Accessories:	0	0	0	0
Payload:	2673	29680	33241	65594
Total:	12014	41850	43136	97000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

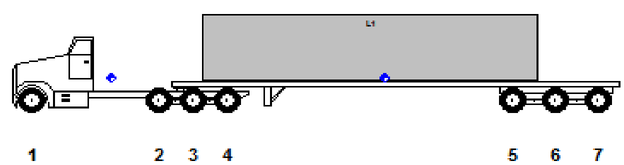
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

BRIDGE FORMULA OPTION:

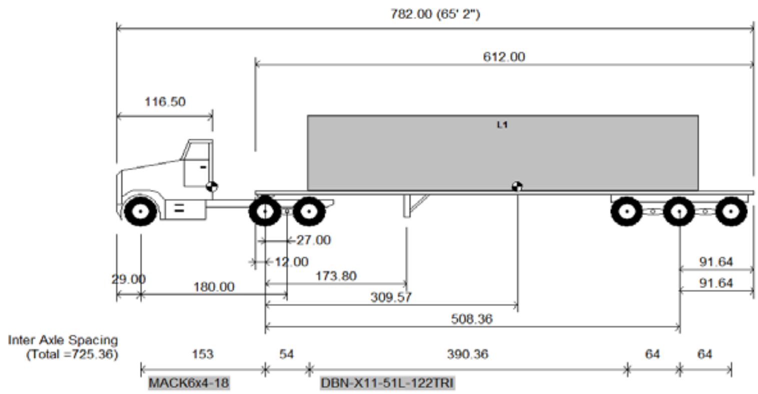
Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb)	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	12014	3 - 6	70500	56658						
2	20000	13950	3 - 7	78000	71036						
3	20000	13950	4 - 5	40000	28329						
4	20000	13950	4 - 6	60000	42708						
5	20000	14379	4 - 7	71500	57086						
6	20000	14379	5 - 6	34000	28757						
7	20000	14379	5 - 7	43500	43136						
1 - 2	40000	25964	6 - 7	34000	28757						
1 - 3	50000	39914									
1 - 4	57500	53864									
1 - 5	83500	68243									
1 - 6	91000	82621									
1 - 7	97000	97000									
2 - 3	34000	27900									
2 - 4	42000	41850									
2 - 5	70000	56229									
2 - 6	77500	70608									
2 - 7	85000	84986									
3 - 4	34000	27900									
3 - 5	60000	42279									

Conf. 23: Mack Granite 6x4 axle forward Tractor, tandem axle, 180" wheel base; 51' Dionbilt X11 fixed 128’’ tridem axle chassis (no lift axles)

23-1. 80,000 lb GVW

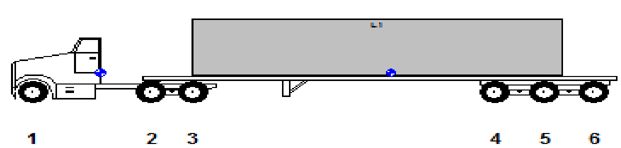


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8683	10715	9758	29156
Accessories:	0	0	0	0
Payload:	3244	18382	29218	50844
Total:	11927	29097	38976	80000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

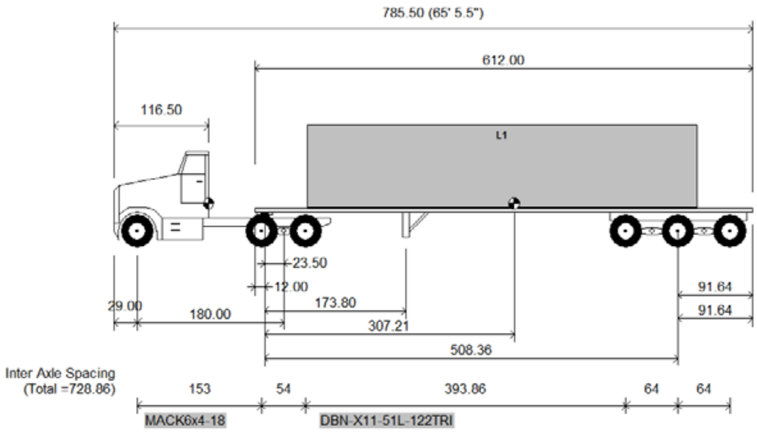


BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb)	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb)	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	11927	5 - 6	34000	25984						
2	20000	14549									
3	20000	14549									
4	20000	12992									
5	20000	12992									
6	20000	12992									
1 - 2	40000	26476									
1 - 3	48500	41024									
1 - 4	75500	54016									
1 - 5	82500	67008									
1 - 6	90000	80000									
2 - 3	34000	29097									
2 - 4	60000	42089									
2 - 5	70000	55081									
2 - 6	78000	68073									
3 - 4	40000	27540									
3 - 5	60000	40532									
3 - 6	70500	53524									
4 - 5	34000	25984									
4 - 6	44000	38976									

23-2. 90,000 lb GVW

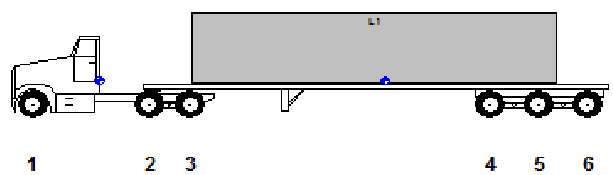


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8617	10781	9758	29156
Accessories:	0	0	0	0
Payload:	3379	22501	34964	60844
Total:	11996	33282	44722	90000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

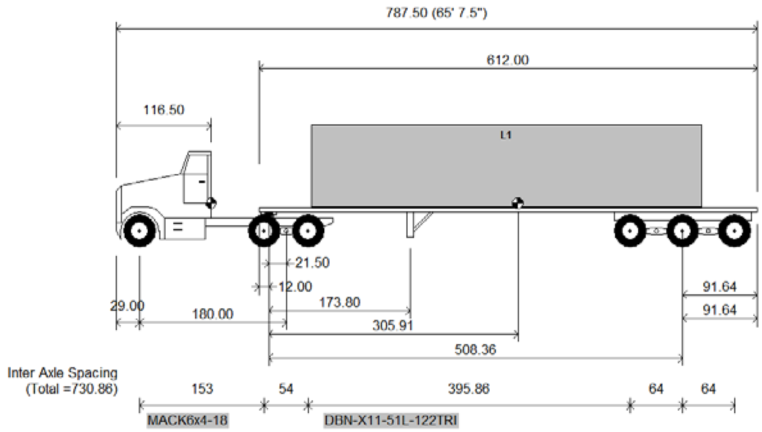


BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb)	Current .oad (lb		Axle Bridge	llowabl .oad (lb)	Current .oad (lb)		Axle Bridge	llowabl .oad (lb)	Current .oad (lb		Axle Bridge	llowabl .oad (lb)	Current .oad (lb	
1	20000	11996		5 - 6	34000	29815									
2	20000	16641													
3	20000	16641													
4	20000	14907													
5	20000	14907													
6	20000	14907													
1 - 2	40000	28637													
1 - 3	48500	45278													
1 - 4	75500	60185													
1 - 5	82500	75093													
1 - 6	90500	90000													
2 - 3	34000	33282													
2 - 4	60000	48189													
2 - 5	70500	63097													
2 - 6	78000	78004	◀												
3 - 4	40000	31548													
3 - 5	60000	46456													
3 - 6	70500	61363													
4 - 5	34000	29815													
4 - 6	44000	44722	◀												

23-3. 97,000 lb GVW

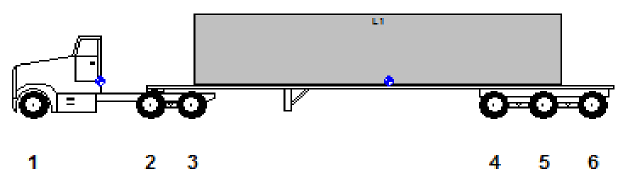


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8579	10819	9758	29156
Accessories:	0	0	0	0
Payload:	3447	25410	38987	67844
Total:	12026	36229	48745	97000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

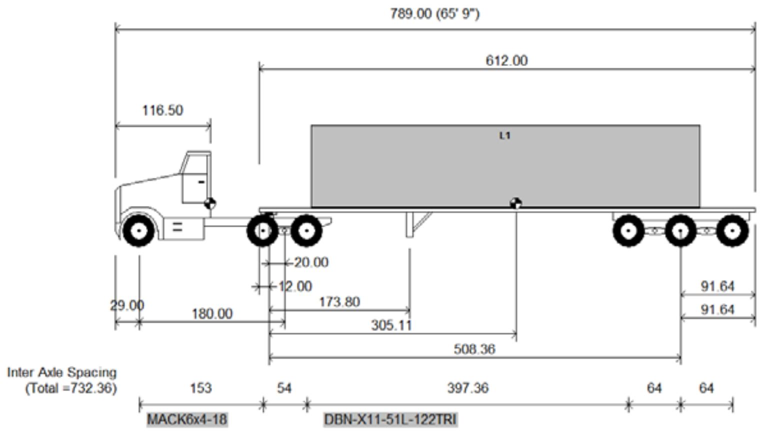


BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb)		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	12026		5 - 6	34000	32497									
2	20000	18115													
3	20000	18115													
4	20000	16248													
5	20000	16248													
6	20000	16248													
1 - 2	40000	30141													
1 - 3	48500	48255													
1 - 4	75500	64503													
1 - 5	83000	80752													
1 - 6	90500	97000	◀												
2 - 3	34000	36229	◀												
2 - 4	60000	52477													
2 - 5	70500	68726													
2 - 6	78000	84974	◀												
3 - 4	40000	34363													
3 - 5	60000	50611													
3 - 6	71500	66859													
4 - 5	34000	32497													
4 - 6	44000	48745	◀												

23-4. 102,000 lb GVW



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8551	10847	9758	29156
Accessories:	0	0	0	0
Payload:	3443	27541	41860	72844
Total:	11994	38388	51618	102000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

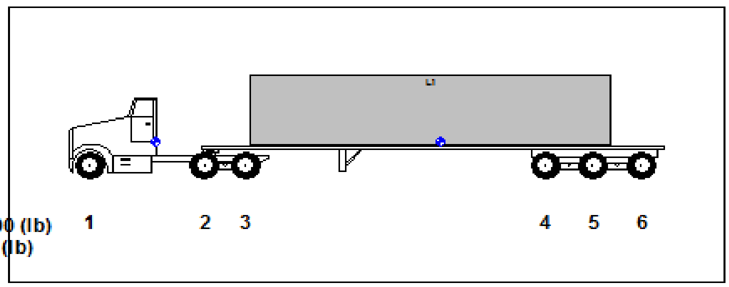
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

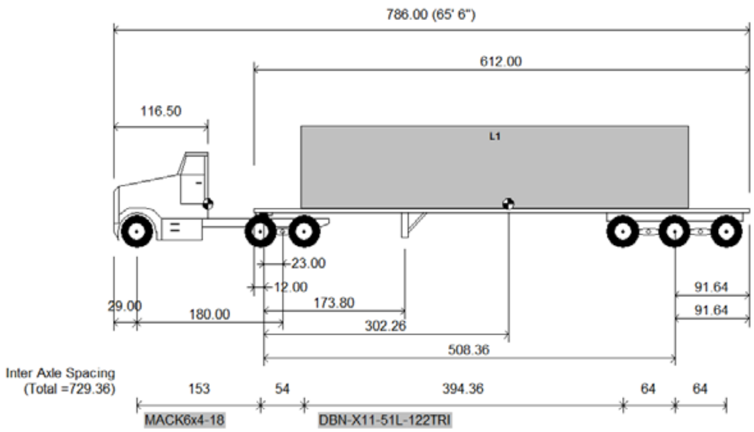
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	11994		5 - 6	34000	34412	◄								
2	20000	19194													
3	20000	19194													
4	20000	17206													
5	20000	17206													
6	20000	17206													
1 - 2	40000	31188													
1 - 3	48500	50382	◄												
1 - 4	75500	67588													
1 - 5	83000	84794	◄												
1 - 6	90500	102000	◄												
2 - 3	34000	38388	◄												
2 - 4	60000	55594													
2 - 5	70500	72800	◄												
2 - 6	78000	90006	◄												
3 - 4	40000	36400													
3 - 5	60000	53606													
3 - 6	71500	70812													
4 - 5	34000	34412	◄												
4 - 6	44000	51618	◄												

23-5. Maximum Payload under U.S Bridge Formula (need move container)

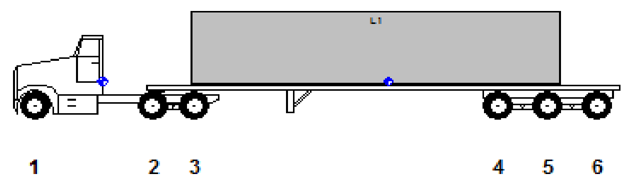


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	8608	10790	9758	29156
Accessories:	0	0	0	0
Payload:	3399	23202	34242	60843
Total:	12007	33992	44000	89999
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



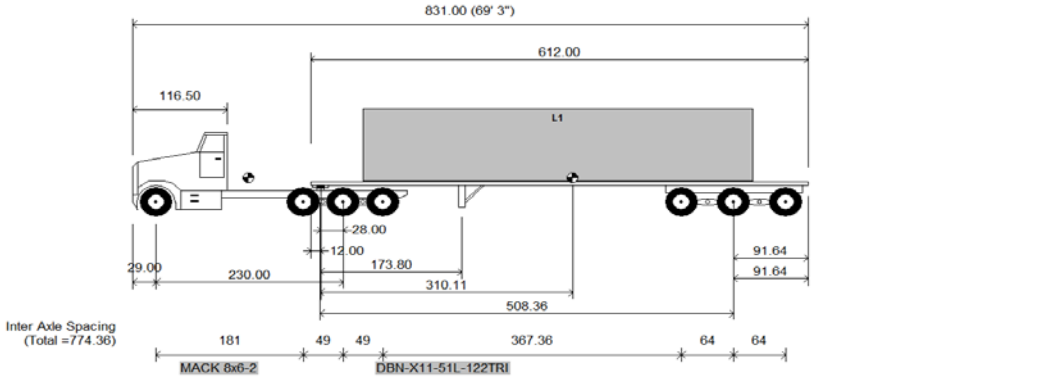
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb)	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	12007	5 - 6	34000	29333						
2	20000	16996									
3	20000	16996									
4	20000	14667									
5	20000	14667									
6	20000	14667									
1 - 2	40000	29003									
1 - 3	48500	45999									
1 - 4	75500	60666									
1 - 5	82500	75332									
1 - 6	90500	89999									
2 - 3	34000	33992									
2 - 4	60000	48659									
2 - 5	70500	63326									
2 - 6	78000	77992									
3 - 4	40000	31663									
3 - 5	60000	46329									
3 - 6	71500	60996									
4 - 5	34000	29333									
4 - 6	44000	44000									

Conf. 24: Mack Granite 8x6 axle forward Tractor, tridem axle, 230" wheel base; 51' Dionbilt X11 fixed 128'' tridem axle chassis (no lift axles)

24-1. 80,000 lb GVW

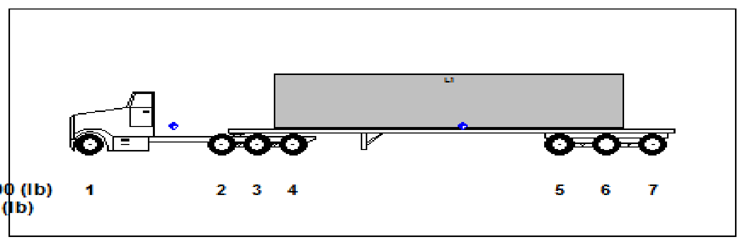


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9457	11851	9758	31066
Accessories:	0	0	0	0
Payload:	2534	18280	28120	48934
Total:	11991	30131	37878	80000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

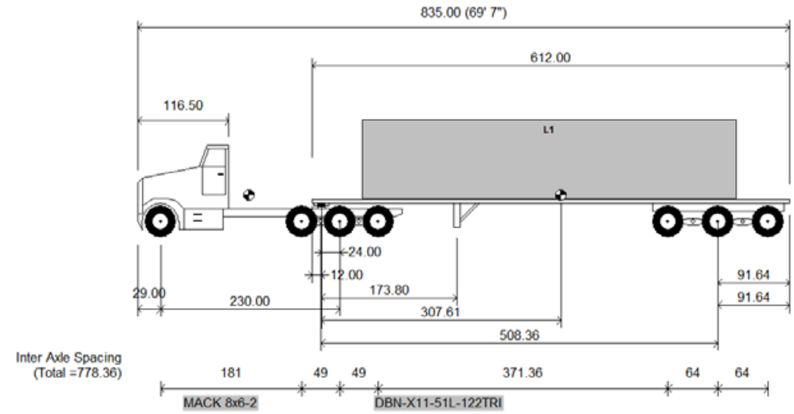
Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl.oad (lb	Current.oad (lb	Axle Bridge	llowabl.oad (lb	Current.oad (lb	Axle Bridge	llowabl.oad (lb	Current.oad (lb	Axle Bridge	llowabl.oad (lb	Current.oad (lb
1	20000	11991	3 - 6	68500	45339						
2	20000	10044	3 - 7	76000	57965						
3	20000	10044	4 - 5	40000	22670						
4	20000	10044	4 - 6	60000	35296						
5	20000	12626	4 - 7	69500	47922						
6	20000	12626	5 - 6	34000	25252						
7	20000	12626	5 - 7	44000	37878						
1 - 2	40000	22035	6 - 7	34000	25252						
1 - 3	50000	32078									
1 - 4	57500	42122									
1 - 5	81500	54748									
1 - 6	89500	67374									
1 - 7	97000	80000									
2 - 3	34000	20087									
2 - 4	42000	30131									
2 - 5	68000	42757									
2 - 6	75500	55383									
2 - 7	83500	68009									
3 - 4	34000	20087									
3 - 5	60000	32713									

24-2. 90,000 lb GVW

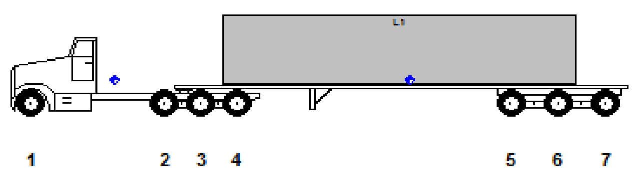


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9398	11910	9758	31066
Accessories:	0	0	0	0
Payload:	2616	22452	33867	58934
Total:	12014	34361	43625	90000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

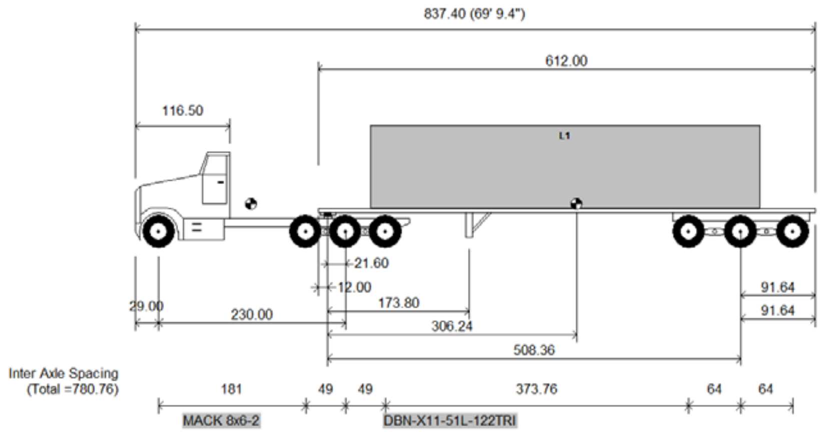


BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb)	Axle Bridge	llowabl .oad (lb	Current .oad (lb	Axle Bridge	llowabl .oad (lb	Current .oad (lb
1	20000	12014	3 - 6	68500	51991						
2	20000	11454	3 - 7	76500	66532						
3	20000	11454	4 - 5	40000	25995						
4	20000	11454	4 - 6	60000	40537						
5	20000	14542	4 - 7	70000	55078						
6	20000	14542	5 - 6	34000	29083						
7	20000	14542	5 - 7	44000	43625						
1 - 2	40000	23468	6 - 7	34000	29083						
1 - 3	50000	34922									
1 - 4	57500	46375									
1 - 5	81500	60917									
1 - 6	90000	75458									
1 - 7	97000	90000									
2 - 3	34000	22908									
2 - 4	42000	34361									
2 - 5	68000	48903									
2 - 6	75500	63445									
2 - 7	84000	77986									
3 - 4	34000	22908									
3 - 5	60000	37449									

24-3. 97,000 lb GVW

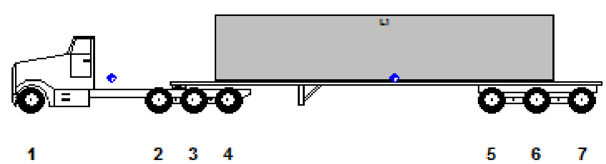


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9363	11945	9758	31066
Accessories:	0	0	0	0
Payload:	2634	25411	37889	65934
Total:	11996	37356	47647	97000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

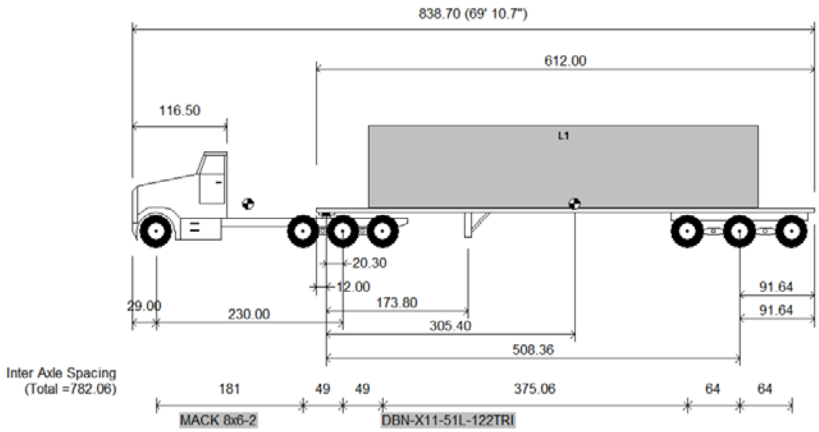


BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb)		Axle Bridge	llowabl .oad (lb	Current .oad (lb		Axle Bridge	llowabl .oad (lb	Current .oad (lb	
1	20000	11996		3 - 6	69500	56669									
2	20000	12452		3 - 7	76500	72551									
3	20000	12452		4 - 5	40000	28335									
4	20000	12452		4 - 6	60000	44217									
5	20000	15882		4 - 7	70000	60099									
6	20000	15882		5 - 6	34000	31765									
7	20000	15882		5 - 7	44000	47647	◀								
1 - 2	40000	24449		6 - 7	34000	31765									
1 - 3	50000	36901													
1 - 4	57500	49353													
1 - 5	81500	65235													
1 - 6	90000	81118													
1 - 7	97000	97000													
2 - 3	34000	24904													
2 - 4	42000	37356													
2 - 5	68000	53239													
2 - 6	76000	69121													
2 - 7	84000	85004	◀												
3 - 4	34000	24904													
3 - 5	60000	40787													

24-4. 102,000 lb GVW

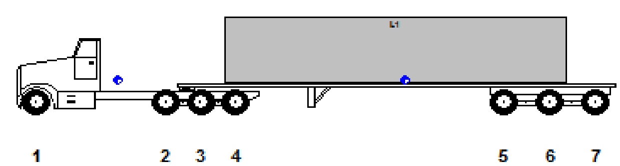


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9343	11964	9758	31066
Accessories:	0	0	0	0
Payload:	2663	27509	40762	70934
Total:	12006	39473	50520	102000
Desired/(GVW)*:	-	-	-	-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

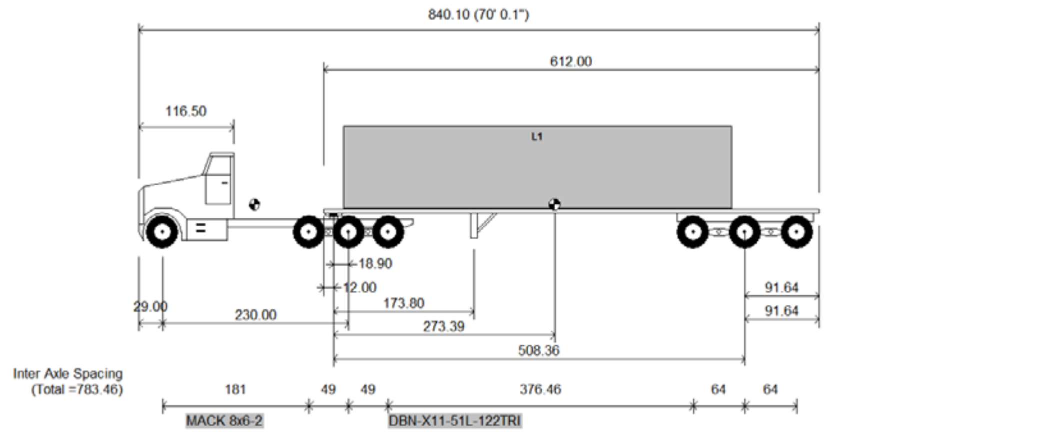


BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	llowabl.oad (lb	Current.oad (lb		Axle Bridge	llowabl.oad (lb	Current.oad (lb)		Axle Bridge	llowabl.oad (lb	Current.oad (lb		Axle Bridge	llowabl.oad (lb	Current.oad (lb	
1	20000	12006		3 - 6	69500	59996									
2	20000	13158		3 - 7	76500	76836	◀								
3	20000	13158		4 - 5	40000	29998									
4	20000	13158		4 - 6	60000	46838									
5	20000	16840		4 - 7	70000	63678									
6	20000	16840		5 - 6	34000	33680									
7	20000	16840		5 - 7	44000	50520	◀								
1 - 2	40000	25164		6 - 7	34000	33680									
1 - 3	50000	38322													
1 - 4	57500	51480													
1 - 5	82500	68320													
1 - 6	90000	85160													
1 - 7	97000	102000	◀												
2 - 3	34000	26315													
2 - 4	42000	39473													
2 - 5	68000	56313													
2 - 6	76000	73153													
2 - 7	84000	89994	◀												
3 - 4	34000	26315													
3 - 5	60000	43156													

24-5. Maximum Payload under U.S Bridge Formula (need move container)



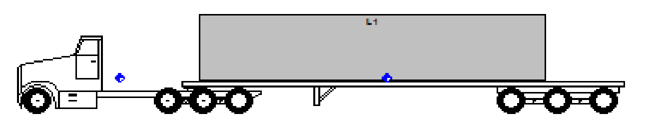
Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9323	11985	9758	31066
Accessories:	0	0	0	0
Payload:	2687	30012	32244	64943
Total:	12010	41997	42002	96009
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	-	-	-	-

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

BRIDGE FORMULA OPTION:
Maximum Gross Vehicle Weight: 97000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb)	Axle Bridge	llowabl Load (lb	Current Load (lb	Axle Bridge	llowabl Load (lb	Current Load (lb
1	20000	12010	3 - 6	69500	55999						
2	20000	13999	3 - 7	76500	70000						
3	20000	13999	4 - 5	40000	28000						
4	20000	13999	4 - 6	60000	42000						
5	20000	14001	4 - 7	70000	56001						
6	20000	14001	5 - 6	34000	28001						
7	20000	14001	5 - 7	44000	42002						
1 - 2	40000	26009	6 - 7	34000	28001						
1 - 3	50000	40008									
1 - 4	57500	54007									
1 - 5	82500	68008									
1 - 6	90000	82008									
1 - 7	97000	96009									
2 - 3	34000	27998									
2 - 4	42000	41997									
2 - 5	68500	55998									
2 - 6	76000	69999									
2 - 7	84000	83999									
3 - 4	34000	27998									
3 - 5	60000	41999									

Appendix E: Analysis of Weight Distribution for 90, 000 lbs Milk Truck

Tare Weight

The weight of tractor for the configurations changes based on the wheelbase, as well as how many axles are on it. The trailer weight varies depending on number of axles, as well as the size of the tank used. The tare weights of each configuration are shown below:

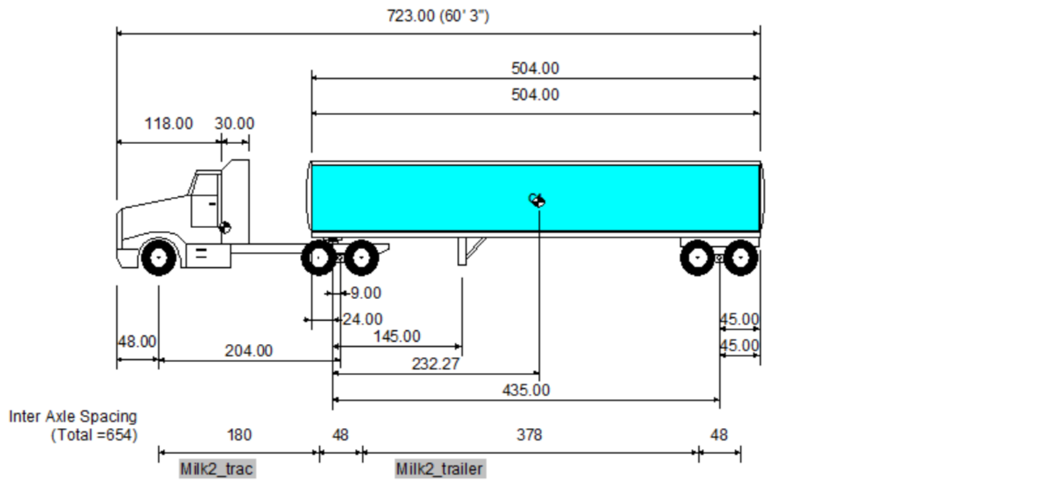
NO.	1-1	1-2	2-1	2-2	2-3
Total Tare Weight	28,500	29,400	30,000	31,500	31,500
Tractor Weight	16,000	17,000	17,000	18,500	17,000
Trailer Weight	12,500	12,400	13,000	13,000	14,500

Overview of Analysis

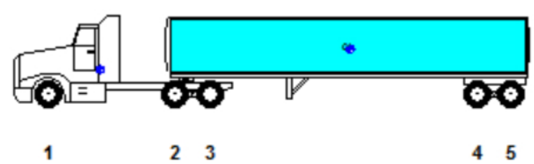
Truck Configuration ID	Truck Description	GVW (lbs)	Tare Weight	FBF violations (axle numbers)
Milk_1-1	5-axle truck with 6,300 gallon tank trailer - 80,000 lbs GVW	80,000	28,500	1-5, 2-3, 4-5
Milk_1-2	5-axle truck with 6,500 gallon tank trailer - 84,000 lbs GVW - agricultural exemption (12% tolerance on one tandem)	84,000	29,400	1-5, 2-3, 2-5, 4-5
Milk_2-1	5-axle truck with 7,000 gallon tank trailer - 90,000 lbs GVW	90,000	30,000	4, 5, 1-5, 2-3, 2-5, 4-5
Milk_2-2	6-axle truck with 7,000 gallon tridem axle tank trailer - 90,000 lbs GVW	90,000	31,500	1-6, 2-6, 4-6
Milk_2-3	6-axle truck with 7,000 gallon trailer tridem axle tractor - 90,000 lbs GVW	90,000	31,500	5, 6, 1-6, 2-6, 3-6, 5-6

Note: FBF violations marked in red are legal (as per the proposed bill, e.g. GVW) and/or are within a small margin of error.

1-1 80,000 lbs GVW (5-axle tractor-trailer – 6,300 gallon tank)



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10435	10885	7181	28500
Accessories:	0	0	0	0
Payload:	1081	23432	27000	51514
Total:	11516	34317	34181	80014
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	14000	38000	38000	(80000*)



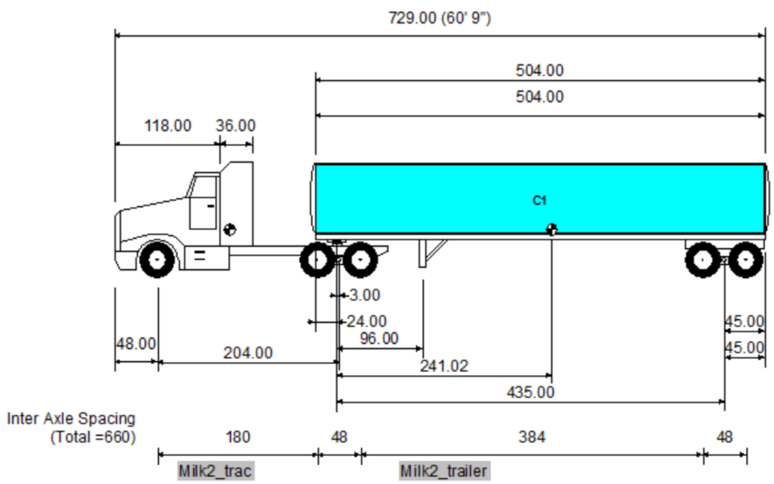
BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	11516													
2	20000	17158													
3	20000	17158													
4	20000	17091													
5	20000	17091													
1 - 2	40000	28675													
1 - 3	50000	45833													
1 - 4	76000	62923													
1 - 5	80000	80014	◀												
2 - 3	34000	34317	◀												
2 - 4	60000	51407													
2 - 5	68500	68498													
3 - 4	40000	34249													
3 - 5	60000	51339													
4 - 5	34000	34181	◀												

◀ = U.S. Bridge Formula Violation

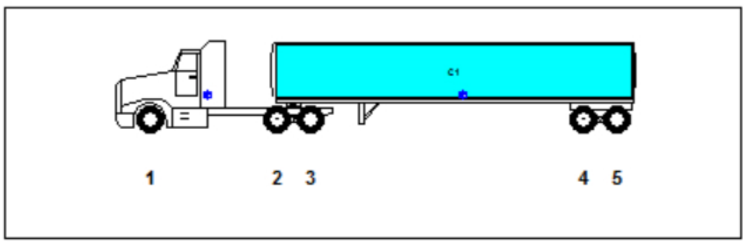
1-2 84,000 lbs GVW (5-axle tractor-trailer with 6,500 gallon tank) – agricultural exemption



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10257	10633	8500	29390
Accessories:	0	0	0	0
Payload:	382	25605	28623	54610
Total:	10639	36237	37123	84000
Desired/(GVW)*:	13200	37400	38080	(84000*)
GAWR/(GVWR*):	-	-	-	-

BRIDGE FORMULA OPTION:

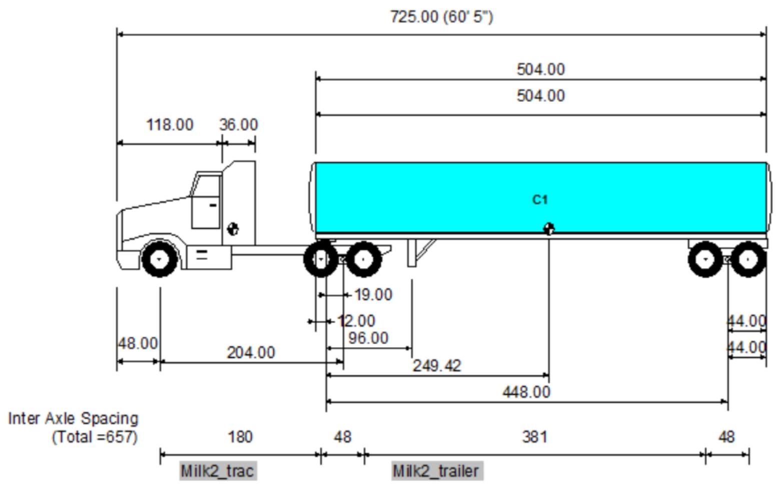
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot



Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	10639													
2	20000	18119													
3	20000	18119													
4	20000	18562													
5	20000	18562													
1 - 2	40000	28758													
1 - 3	50000	46877													
1 - 4	76000	65438													
1 - 5	80000	84000	◀												
2 - 3	34000	36237	◀												
2 - 4	60000	54799													
2 - 5	68500	73361	◀												
3 - 4	40000	36680													
3 - 5	60000	55242													
4 - 5	34000	37123	◀												

◀ = U.S. Bridge Formula Violation

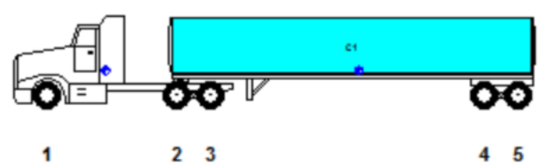
2-1 90,000 lbs GVW (5-axle tractor trailer with 7,000 gallon tank)



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10619	10881	8500	30000
Accessories:	0	0	0	0
Payload:	2595	25264	32144	60002
Total:	13214	36144	40644	90002
Desired/(GVW)*:	14000	38000	38000	(90000*)
GAWR/(GVWR*):	-	-	-	-

BRIDGE FORMULA OPTION:

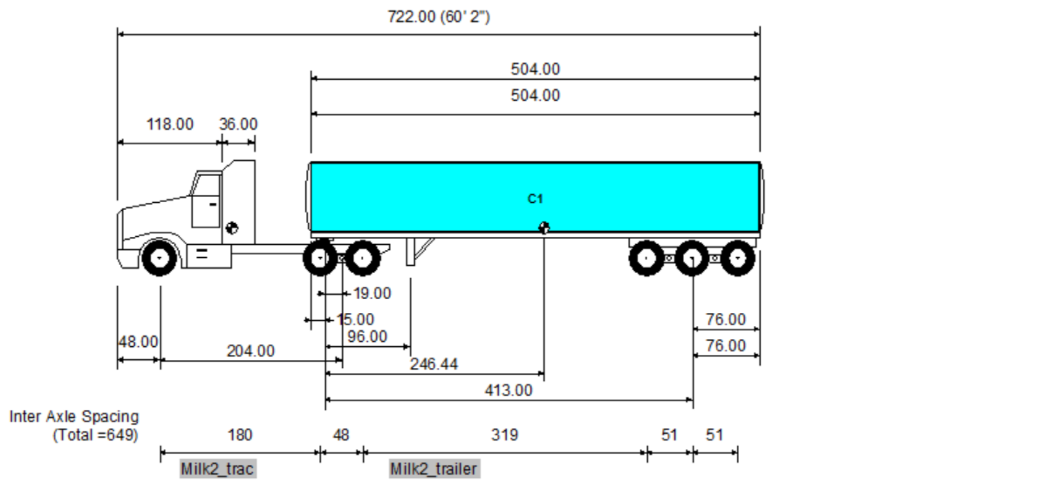
Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	13214													
2	20000	18072													
3	20000	18072													
4	20000	20322	◄												
5	20000	20322	◄												
1 - 2	40000	31286													
1 - 3	50000	49358													
1 - 4	76000	69680													
1 - 5	80000	90002	◄												
2 - 3	34000	36144	◄												
2 - 4	60000	56466													
2 - 5	68500	76788	◄												
3 - 4	40000	38394													
3 - 5	60000	58716													
4 - 5	34000	40644	◄												

◄ = U. S. Bridge Formula Violation

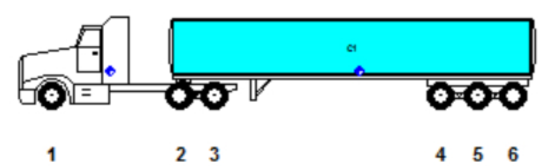
2-2. 90,000 lbs GVW (6-axle tractor trailer with 7,000 gallon tank, with triple-axle group on trailer)



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	10621	10899	10000	31520
Accessories:	0	0	0	0
Payload:	2321	22600	33559	58480
Total:	12942	33499	43559	90000
Desired/(GVW)*:	14000	34000	42000	-
GAWR/(GVWR*):	-	-	-	-

BRIDGE FORMULA OPTION:

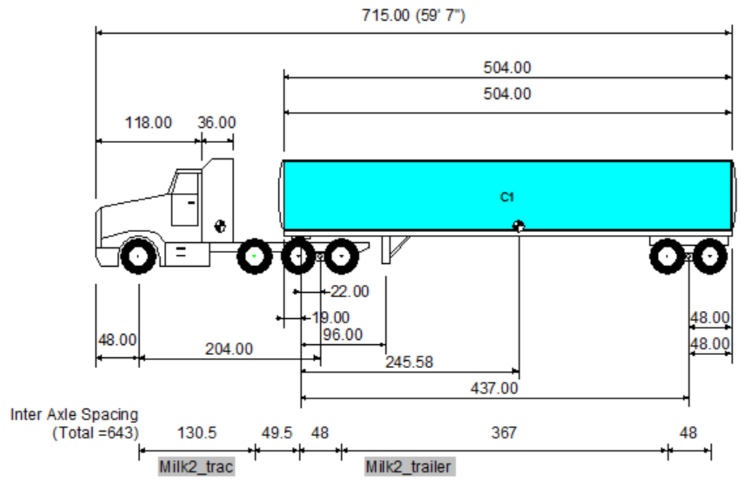
Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	12942		5 - 6	34000	29039									
2	20000	16750													
3	20000	16750													
4	20000	14520													
5	20000	14520													
6	20000	14520													
1 - 2	40000	29692													
1 - 3	50000	46441													
1 - 4	72500	60961													
1 - 5	79000	75480													
1 - 6	80000	90000	◀												
2 - 3	34000	33499													
2 - 4	59000	48019													
2 - 5	65500	62538													
2 - 6	72500	77058	◀												
3 - 4	40000	31269													
3 - 5	59000	45789													
3 - 6	65500	60308													
4 - 5	34000	29039													
4 - 6	42500	43559	◀												

◀ = U.S. Bridge Formula Violation

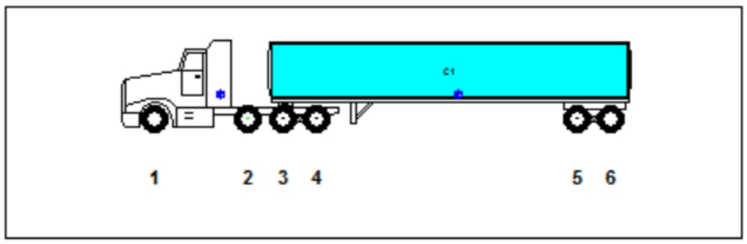
2-3. 90,000 lbs GVW (6-axle tractor trailer with 7,000 gallon tank, with triple-axle group on tractor)



Axle Loads:	#1 (lb)	#3 (lb)	#2 (lb)	#4 (lb)	Total (lb)
Tare:	10610	0	11910	9000	31520
Accessories:	0	0	0	0	0
Payload:	782	6000	20517	31180	58480
Total:	11392	6000	32427	40180	90000
Desired/(GVW)*:	14000	6000	42000	34000	(90000*)
GAWR/(GVWR*):	-	-	-	-	-

BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	11392		5 - 6	34000	40180	◀								
2	20000	6000													
3	20000	16214													
4	20000	16214													
5	20000	20090	◀												
6	20000	20090	◀												
1 - 2	40000	17392													
1 - 3	47000	33606													
1 - 4	54500	49820													
1 - 5	79000	69910													
1 - 6	80000	90000	◀												
2 - 3	34000	22214													
2 - 4	42000	38427													
2 - 5	68000	58517													
2 - 6	75000	78608	◀												
3 - 4	34000	32427													
3 - 5	60000	52517													
3 - 6	68000	72608	◀												
4 - 5	40000	36304													
4 - 6	60000	56394													

◀ = U.S. Bridge Formula Violation

Appendix F: Analysis of Axle Load Distribution for Ready Mix Trucks

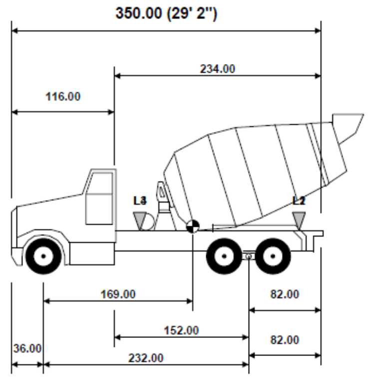
Overview of Analysis

Truck Configuration ID	Truck Description	GVW (lbs)	Tare weight	FBF violations (axle numbers)
Ready mix_1-1	3-axle ready mix truck	46,800	30,000	2-3
Ready mix_1-2	3-axle ready mix Truck	62,800	30,000	2, 3, 1-3, 2-3
ReadyMix_1-3	3-axle ready mix truck	69,000	30,000	2, 3, 1-2, 1-3, 2-3
Ready mix_2-1	SU-4 4-axle ready mix truck with 1 booster axle	69,000	31,000	1, 1-3, 1-4, 2-3
Ready mix_2-2	SU-4 4-axle ready mix truck with 1 pusher axle	69,000	32,000	3, 4, 1-4, 2-4, 3-4
Ready mix_2-3	SU-4 4-axle ready mix truck with 1 pusher axle	70,100	31,000	3, 4, 1-4, 2-4, 3-4.
Ready mix_2-4	SU-4 4-axle ready mix truck with 1 booster axle	70,100	31,000	1, 1-2,1-3, 1-4, 2-3
Ready mix_3-2	SU-5 5-axle ready mix truck with 1 pusher axle and 1 booster axle	69,000	34,000	none
Ready mix_3-3	SU-5 5-axle ready mix truck with 1 pusher axle and 1 booster axle	70,500	34,000	1-4
Ready mix_4-2	SU-6 6-axle ready mix truck with 2 pusher axles and 1 booster axle	69,000	33,000	none
Ready mix_4-3	SU-6 6-axle ready mix truck with 2 pusher axles and 1 booster axle	75,500	36,000	1-5
Ready mix_5-2	SU-7 7-axle ready mix truck with 3 pusher axles and 1 booster axle	69,000	35,000	none
Ready mix_5-4	SU-7 7-axle ready mix truck with 3 pusher axles and 1 booster axle	80,000	38,000	none

1-1. 3 axle ready mix truck configuration with GVW 46,800 lbs

All lengths in inches and weights in pounds

Printout of Load Xpert software



Inter Axle Spacing
(Total =259.5)

204.5 55

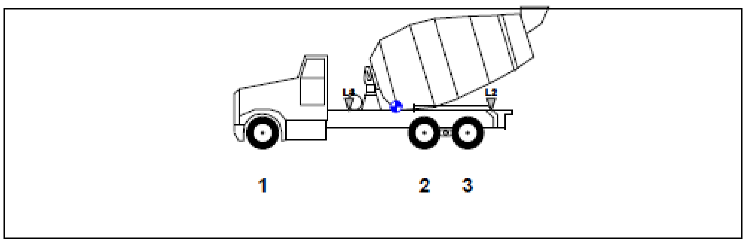
Ready Mix

Axle Loads:	#1 (lb)	#2 (lb)	Total (lb)
Tare:	8364	21636	30000
Accessories:	0	0	0
Payload:	4345	12455	16800
Total:	12709	34091	46800
Desired/(GVW)*:	U.S. Bridge Formula		-
GAWR/(GVWR*):	23000	46000	(70100*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	12709													
2	20000	17045													
3	20000	17045													
1 - 2	40000	29754													
1 - 3	52500	46800													
2 - 3	34000	34091	◀												

◀ = U.S. Bridge Formula Violation

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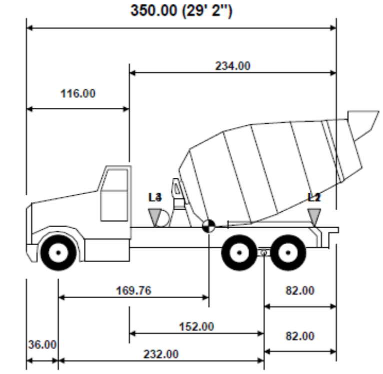
1-2. 3 axle ready mix truck configuration with GVW 62,800 lbs

All lengths in inches and weights in pounds | **Printout of Load Xpert software**



Inter Axle Spacing (Total =259.5): 204.5 | 55

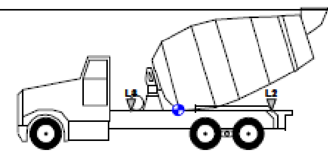
Ready Mix

Axle Loads:	#1 (lb)	#2 (lb)	Total (lb)
Tare:	8364	21636	30000
Accessories:	0	0	0
Payload:	8483	24317	32800
Total:	16847	45953	62800
Desired/(GVW)*:	U.S. Bridge Formula		-
GAWR/(GVWR*):	23000	46000	(70100*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	16847													
2	20000	22976	◀												
3	20000	22976	◀												
1 - 2	40000	39823													
1 - 3	52500	62800	◀												
2 - 3	34000	45953	◀												

◀ = U.S. Bridge Formula Violation

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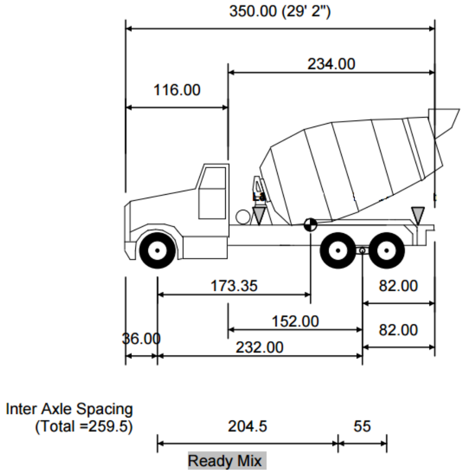
1-3. 3 axle ready mix truck configuration with GVW 69,000 lbs

All lengths in inches and weights in pounds | **Printout of Load Xpert software**

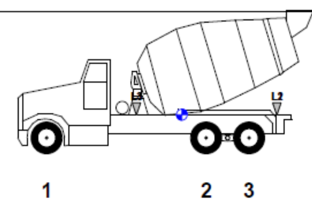


Axle Loads:	#1 (lb)	#2 (lb)	Total (lb)
Tare:	8364	21636	30000
Accessories:	0	0	0
Payload:	9078	29922	39000
Total:	17442	51558	69000
Desired/(GVW)*:	U.S. Bridge Formula		-
GAWR/(GVWR*):	23000	46000	(70100*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

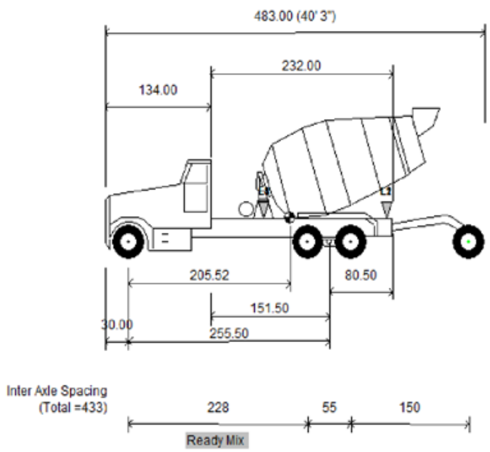
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	17442													
2	20000	25779	◄												
3	20000	25779	◄												
1 - 2	40000	43221	◄												
1 - 3	52500	69000	◄												
2 - 3	34000	51558	◄												

◄ = U.S. Bridge Formula Violation

Page 1 of 1

2-1. 4 axle ready mix truck configuration with 1 booster axle with GVW 69,000 lbs



Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9200	21800	0	31000
Accessories:	0	0	0	0
Payload:	12635	13365	12000	38000
Total:	21834	35166	12000	69000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	23000	46000	12000	(70100*)

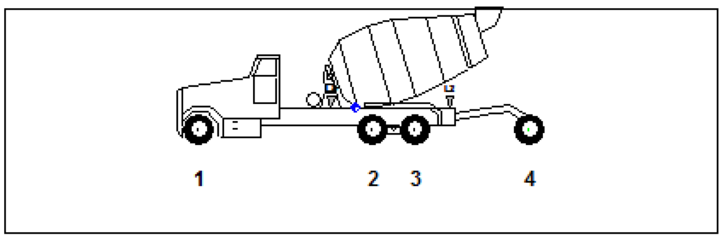
U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:

BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot



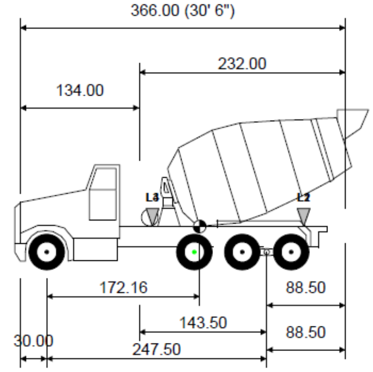
Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	21834	◀												
2	20000	17583													
3	20000	17583													
4	20000	12000													
1 - 2	40000	39417													
1 - 3	54000	57000	◀												
1 - 4	66000	69000	◀												
2 - 3	34000	35166	◀												
2 - 4	48500	47166													
3 - 4	40000	29583													

◀ = U. S. Bridge Formula Violation

Page 1 of 1

2-2. 4 axle ready mix truck configuration with 1 pusher axle with GVW 69,000 lbs

All lengths in inches and weights in pounds — **Printout of Load Xpert software**



Inter Axle Spacing (Total =275): 166 | 54 | 55

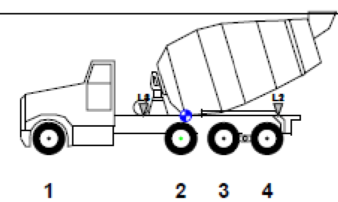
Ready Mix

Axle Loads:	#1 (lb)	#3 (lb)	#2 (lb)	Total (lb)
Tare:	10661	0	21339	32000
Accessories:	0	0	0	0
Payload:	7708	8000	21292	37000
Total:	18369	8000	42631	69000
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	23000	-	46000	(70100*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



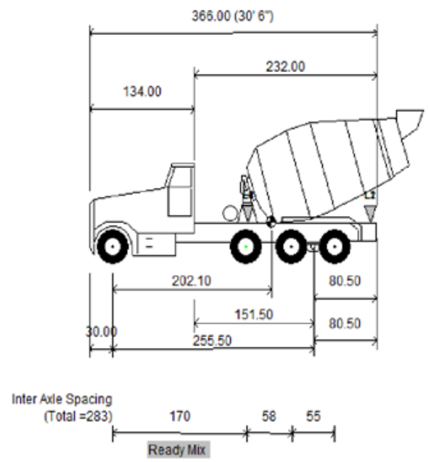
BRIDGE FORMULA OPTION:
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	18369													
2	20000	8000													
3	20000	21316	◀												
4	20000	21316	◀												
1 - 2	40000	26369													
1 - 3	49500	47684													
1 - 4	57500	69000	◀												
2 - 3	34000	29316													
2 - 4	42500	50631	◀												
3 - 4	34000	42631	◀												

◀ = U.S. Bridge Formula Violation

Page 1 of 1

2-3. 4 axle ready mix truck configuration with 1 pusher axle with GVW 70,100 lbs

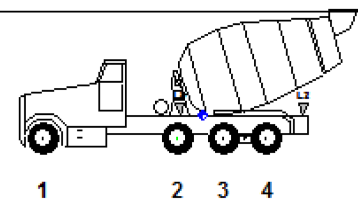


Axle Loads:	#1 (lb)	#3 (lb)	#2 (lb)	Total (lb)
Tare:	10229	0	20771	31000
Accessories:	0	0	0	0
Payload:	1745	8000	29355	39100
Total:	11974	8000	50126	70100
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	23000	8000	46000	(70100*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

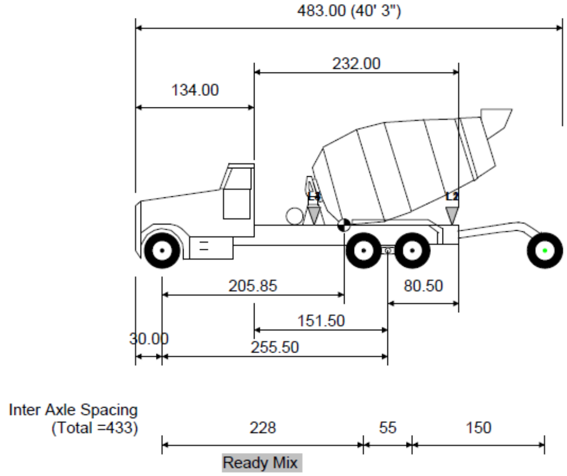
Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	11974													
2	20000	8000													
3	20000	25063	◀												
4	20000	25063	◀												
1 - 2	40000	19974													
1 - 3	50000	45037													
1 - 4	58000	70100	◀												
2 - 3	34000	33063													
2 - 4	42500	58126	◀												
3 - 4	34000	50126	◀												

◀ = U.S. Bridge Formula Violation

Page 1 of 1

2-4. 4 axle ready mix truck configuration with 1 booster axle with GVW 70,100 lbs

All lengths in inches and weights in pounds **Printout of Load Xpert software**

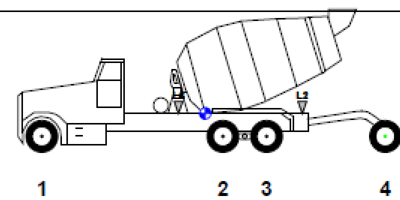


Axle Loads:	#1 (lb)	#2 (lb)	#3 (lb)	Total (lb)
Tare:	9200	21800	0	31000
Accessories:	0	0	0	0
Payload:	12759	14341	12000	39100
Total:	21958	36142	12000	70100
Desired/(GVW)*:	U.S. Bridge Formula			-
GAWR/(GVWR*):	23000	46000	12000	(70100*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	21958	◄
2	20000	18071	
3	20000	18071	
4	20000	12000	
1 - 2	40000	40029	◄
1 - 3	54000	58100	◄
1 - 4	66000	70100	◄
2 - 3	34000	36142	◄
2 - 4	48500	48142	
3 - 4	40000	30071	

◄ = U.S. Bridge Formula Violation

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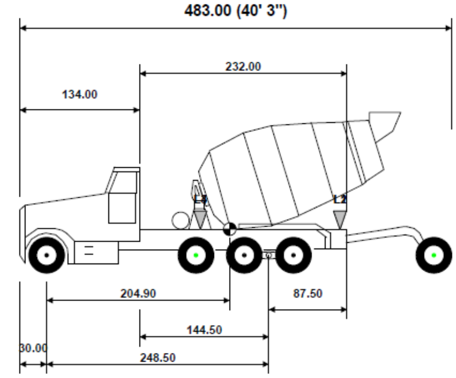
3-2. 5 axle ready mix truck configuration with GVW 69,000 lbs

All lengths in inches and weights in pounds

Printout of Load Xpert software



Inter Axle Spacing (Total =433) 167 54 55 157

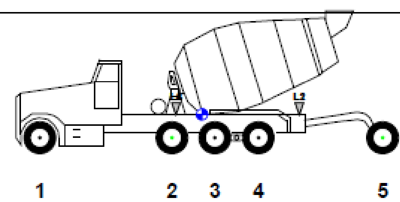
Ready Mix

Axle Loads:	#1 (lb)	#3 (lb)	#2 (lb)	#4 (lb)	Total (lb)
Tare:	9022	0	24978	0	34000
Accessories:	0	0	0	0	0
Payload:	10912	3300	8788	12000	35000
Total:	19934	3300	33766	12000	69000
Desired/(GVW)*:	U.S. Bridge Formula				-
GAWR/(GVWR*):	20000	8000	34000	12000	(70500*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:
Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

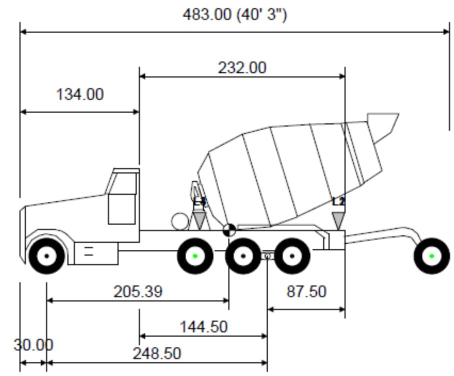
Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	19934													
2	20000	3300													
3	20000	16883													
4	20000	16883													
5	20000	12000													
1 - 2	40000	23234													
1 - 3	49500	40117													
1 - 4	57500	57000													
1 - 5	70500	69000													
2 - 3	34000	20183													
2 - 4	42500	37066													
2 - 5	56500	49066													
3 - 4	34000	33766													
3 - 5	49500	45766													
4 - 5	40000	28883													

◄ = U.S. Bridge Formula Violation

Page 1 of 1

3-3. 5 axle ready mix truck configuration with GVW 70,500 lbs

All lengths in inches and weights in pounds | **Printout of Load Xpert software**



Inter Axle Spacing (Total =433) 167 54 55 157

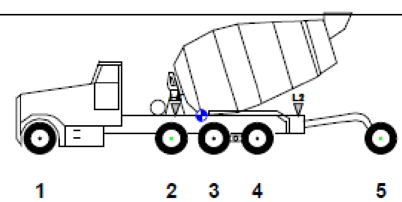
Ready Mix

Axle Loads:	#1 (lb)	#3 (lb)	#2 (lb)	#4 (lb)	Total (lb)
Tare:	9022	0	24978	0	34000
Accessories:	0	0	0	0	0
Payload:	10841	5700	7159	12800	36500
Total:	19863	5700	32137	12800	70500
Desired/(GVW)*:	U.S. Bridge Formula				-
GAWR/(GVWR*):	20000	8000	34000	12000	(70500*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

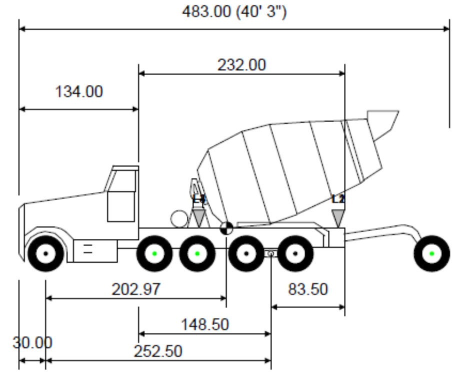
- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	19863													
2	20000	5700													
3	20000	16068													
4	20000	16068													
5	20000	12800													
1 - 2	40000	25563													
1 - 3	49500	41632													
1 - 4	57500	57700	◀												
1 - 5	70500	70500													
2 - 3	34000	21768													
2 - 4	42500	37837													
2 - 5	56500	50637													
3 - 4	34000	32137													
3 - 5	49500	44937													
4 - 5	40000	28868													

◀ = U.S. Bridge Formula Violation | **Page 1 of 1**

4-2. 6 axle ready mix truck configuration with GVW 69,000 lbs

All lengths in inches and weights in pounds **Printout of Load Xpert software**



Inter Axle Spacing (Total =433) 122 48 55 55 153

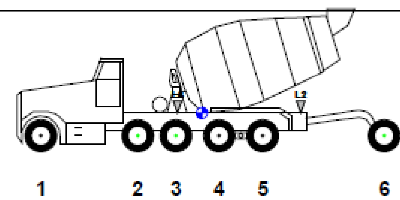
Ready Mix

Axle Loads:	#1 (lb)	#3 (lb)	#4 (lb)	#2 (lb)	#5 (lb)	Total (lb)
Tare:	9844	0	0	23156	0	33000
Accessories:	0	0	0	0	0	0
Payload:	2306	8000	8000	10194	7500	36000
Total:	12149	8000	8000	33351	7500	69000
Desired/(GVW)*:	U.S. Bridge Formula					-
GAWR/(GVWR*):	20000	8000	8000	34000	12000	(75500*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

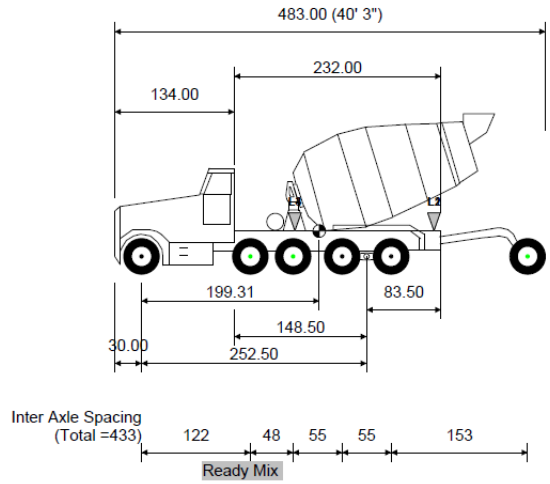
Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)	Axle Bridge	Allowable Load (lb)	Current Load (lb)	Axle Bridge	Allowable Load (lb)	Current Load (lb)	Axle Bridge	Allowable Load (lb)	Current Load (lb)
1	20000	12149	5 - 6	40000	24175						
2	20000	8000									
3	20000	8000									
4	20000	16675									
5	20000	16675									
6	20000	7500									
1 - 2	40000	20149									
1 - 3	46500	28149									
1 - 4	54500	44825									
1 - 5	62500	61500									
1 - 6	75500	69000									
2 - 3	34000	16000									
2 - 4	42500	32675									
2 - 5	50500	49351									
2 - 6	64000	56851									
3 - 4	34000	24675									
3 - 5	42500	41351									
3 - 6	56500	48851									
4 - 5	34000	33351									
4 - 6	48500	40851									

◄ = U.S. Bridge Formula Violation **Page 1 of 1**

4-3. 6 axle ready mix truck configuration with GVW 75,500 lbs

All lengths in inches and weights in pounds **Printout of Load Xpert software**

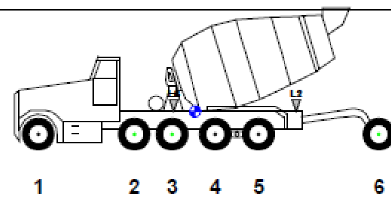


Axle Loads:	#1 (lb)	#3 (lb)	#4 (lb)	#2 (lb)	#5 (lb)	Total (lb)
Tare:	11844	0	0	24156	0	36000
Accessories:	0	0	0	0	0	0
Payload:	5176	8000	8000	7324	11000	39500
Total:	17019	8000	8000	31481	11000	75500
Desired/(GVW)*:	U.S. Bridge Formula					-
GAWR/(GVWR*):	20000	8000	8000	34000	12000	(75500*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

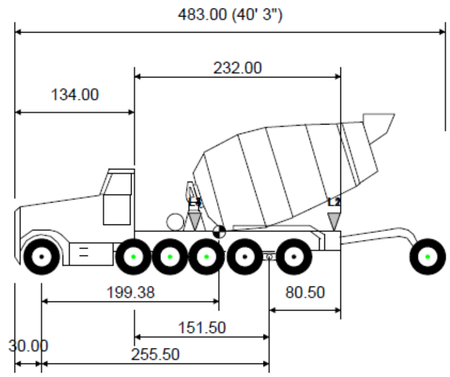
Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)		Axle Bridge	Allowable Load (lb)	Current Load (lb)	
1	20000	17019		5 - 6	40000	26740									
2	20000	8000													
3	20000	8000													
4	20000	15740													
5	20000	15740													
6	20000	11000													
1 - 2	40000	25019													
1 - 3	46500	33019													
1 - 4	54500	48760													
1 - 5	62500	64500	◀												
1 - 6	75500	75500													
2 - 3	34000	16000													
2 - 4	42500	31740													
2 - 5	50500	47481													
2 - 6	64000	58481													
3 - 4	34000	23740													
3 - 5	42500	39481													
3 - 6	56500	50481													
4 - 5	34000	31481													
4 - 6	48500	42481													

◀ = U.S. Bridge Formula Violation **Page 1 of 1**

5-2. 7 axle ready mix truck configuration with GVW 69,000 lbs

All lengths in inches and weights in pounds **Printout of Load Xpert software**



Inter Axle Spacing (Total =433) 103 41 41 43 55 150

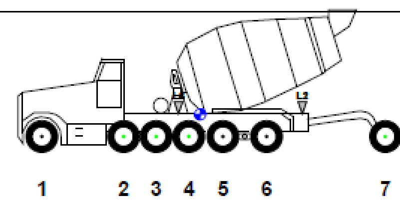
Ready Mix

Axle Loads:	#1 (lb)	#3 (lb)	#4 (lb)	#5 (lb)	#2 (lb)	#6 (lb)	Total (lb)
Tare:	11309	0	0	0	23691	0	35000
Accessories:	0	0	0	0	0	0	0
Payload:	3552	5000	5000	5000	6448	9000	34000
Total:	14861	5000	5000	5000	30139	9000	69000
Desired/(GVW)*:	U.S. Bridge Formula						-
GAWR/(GVWR*):	20000	8000	8000	8000	34000	12000	(80000*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

- Maximum Gross Vehicle Weight: 80000 (lb)
- Maximum Load on axles with single tire: 20000 (lb)
- Permissible Load rounded to the nearest 500 (lb)
- Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)	Axle Bridge	Allowable Load (lb)	Current Load (lb)	Axle Bridge	Allowable Load (lb)	Current Load (lb)	Axle Bridge	Allowable Load (lb)	Current Load (lb)
1	20000	14861	3 - 6	50000	40139						
2	20000	5000	3 - 7	63000	49139						
3	20000	5000	4 - 5	34000	20069						
4	20000	5000	4 - 6	42000	35139						
5	20000	15069	4 - 7	56000	44139						
6	20000	15069	5 - 6	34000	30139						
7	20000	9000	5 - 7	48500	39139						
1 - 2	39000	19861	6 - 7	40000	24069						
1 - 3	45000	24861									
1 - 4	52000	29861									
1 - 5	60000	44931									
1 - 6	68500	60000									
1 - 7	80000	69000									
2 - 3	34000	10000									
2 - 4	34000	15000									
2 - 5	48500	30069									
2 - 6	57500	45139									
2 - 7	71000	54139									
3 - 4	34000	10000									
3 - 5	34000	25069									

◀ = U.S. Bridge Formula Violation

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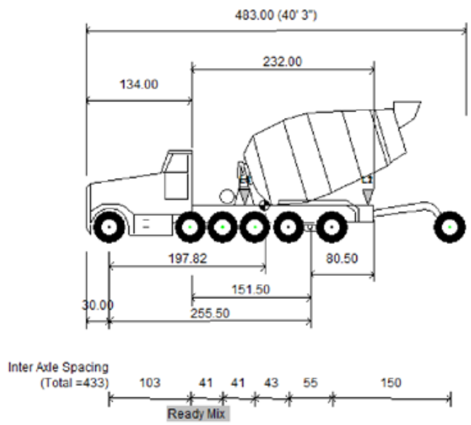
5-4. 7 axle ready mix truck configuration with GVW 74,000 lbs

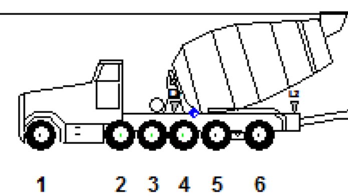


Axle Loads:	#1 (lb)	#3 (lb)	#4 (lb)	#5 (lb)	#2 (lb)	#6 (lb)	Total (lb)
Tare:	13309	0	0	0	24691	0	38000
Accessories:	0	0	0	0	0	0	0
Payload:	2614	8000	8000	8000	3386	12000	42000
Total:	15923	8000	8000	8000	28077	12000	80000
Desired/(GVW)*:	U.S. Bridge Formula						-
GAWR/(GVWR*):	20000	8000	8000	8000	34000	12000	(80000*)

U.S. BRIDGE FORMULA for

Printout of Load Xpert software

Company:
Ref.:
Date:



BRIDGE FORMULA OPTION:

Maximum Gross Vehicle Weight: 80000 (lb)
Maximum Load on axles with single tire: 20000 (lb)
Permissible Load rounded to the nearest 500 (lb)
Bridge length rounded to the nearest foot

Axle Bridge	Allowable Load (lb)	Current Load (lb)	Axle Bridge	Allowable Load (lb)	Current Load (lb)	Axle Bridge	Allowable Load (lb)	Current Load (lb)	Axle Bridge	Allowable Load (lb)	Current Load (lb)
1	20000	15923	3 - 6	50000	44077						
2	20000	8000	3 - 7	63000	56077						
3	20000	8000	4 - 5	34000	22039						
4	20000	8000	4 - 6	42000	36077						
5	20000	14039	4 - 7	56000	48077						
6	20000	14039	5 - 6	34000	28077						
7	20000	12000	5 - 7	48500	40077						
1 - 2	39000	23923	6 - 7	40000	26039						
1 - 3	45000	31923									
1 - 4	52000	39923									
1 - 5	60000	53961									
1 - 6	68500	68000									
1 - 7	80000	80000									
2 - 3	34000	16000									
2 - 4	34000	24000									
2 - 5	48500	38039									
2 - 6	57500	52077									
2 - 7	71000	64077									
3 - 4	34000	16000									
3 - 5	34000	30039									

◄ = U.S. Bridge Formula Violation

Page 1 of 1

Appendix G: Workshop II Sign-in Sheet

OS/OW Stakeholders Workshop II Date: July 18, 2016

	Print Name	Industry/Company Represented	Email Address
1.	Chris Lechner	Precast Concrete mfgs Association	Lechner@PcmATexas.org
2.	David Maher	PCMA	dwm1116@Aol.Com
3.	Ed Small	Texas Forestry	esmall@Jw.com
4.	Rob Harrison	CTR	harrison@mail.utexas.edu
5.	Les Findeisen	TXTA	les@texastrucking.com
6.	HM Ruthe	H-GAC	hans-michael.ruthe@h-gac.com
7.	J Pete Laney	Texas Assoc. of Dairymen	jpete@jpetelaneylaw.com
8.	Clint Hackney	PCMA of TX	cphackney@yahoo.com
9.	Ernest White	Houston PD	Ernest.White@HoustonPolice.org
10.	Chapel Love	Houston P.D	Chapel.Love@HoustonPolice.org
11.	Jorge Hinojosa	Bexar Concrete	jorge.hinojosa@bexarconcrete.com
12.	Swati Agarwal	UT-CTR	swatiagarwal@utexas.edu
13.	Lisa loftus-otway	UT-CTR	loftusotway@mail.utexas.edu
14.	Mark Borskey	TXTA	Mark@borskeygr.com
15.	James Terrell	Select Milk	talltexan2@gmail.com

OS/OW Stakeholders Workshop II Date: July 18, 2016

	Print Name	Industry/Company Represented	Email Address
1.	Laura Matz	KCS, Tx Short line Assn, BNSF	Laura@Matzandco.com
2.	Lindsay Mullins	BNSF Railway	Lindsay.mullins@BNSF.com
3.	Dennis Kearns	BNSF Railway	denniskearns@yahoo.com
4.	Nan Jiang	CTR	Jiang@utexas.edu
5.	JJ Rocha	TML	jj@tml.org
6.	Sam Talaber	TX DoT	samuel.talaber@txdot.gov
7.	ALLEN BEINKE	TACA	abeinke@tuggeyllp.com
8.	CARL WEEKS	TX DPS	CARL.WEEKS@DPS.TEXAS.GOV.
9.	Tony Bennett	TX Assn Manufacturers	tony.bennett@manufacturetexas.org
10.	JOSH WINEGARNER	TX CATTLE FEEDERS ASSN.	josh@tcfa.org
11.	MARK McDaniel	TXDOT-MNT	mark.mcdaniel@txdot.gov
12.	Angela Weissmann	UTSA	Angela.weissmann@utsa.edu
13.	Jose Weissmann	UTSA	Jose.Weissmann@utsa.edu
14.			
15.			

OS/OW Stakeholders Workshop II

Date: July 18, 2016

	Print Name	Industry/Company Represented	Email Address
1.	Jennifer Newton	AGC of Texas	jnewton@agctx.org
2.	Carrie Ruppreath	TX Aggregates + Concrete Assoc.	cruppreath@winstead.com
3.	Hui Wu	UT-CTR	wuhui@utexas.edu
4.	MONTY WYNN	TML	monty@tml.org
5.	TONIA NORMAN	TxDOT	tonia.norman@txdot.gov
6.	Chris Nordloh	TXDPS	chris.nordloh@dps.texas.gov
7.	John Dahill	TX Conference of Urban Counties	john@cuc.org
8.	Nicholas Nemec	TxDOT	Nicholas.Nemec@txdot.gov
9.	Colin Parrish	TX Coalition for Trans Prod.	cparrish@gandpaffairs.com
10.	Rick Thompson	TAC	rickt@county.org
11.	JORGE PROZZI	UT AUSTIN	
12.	Kale Driemeier	TXDOT	
13.			
14.			
15.			

Appendix H: Workshop II Presentation

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Oversize / Overweight Vehicle Workshop II

TxDOT D.C. Greer Building
Ric Williamson Hearing Room

July 18, 2016

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IAC Manager – Tonia Norman
Project Management Blake Calvert

UT –CTR Contract Supervisor – Professor C. Michael Walton, P.E.

Project Team Members

UT-CTR

Dr. Jorge Prozzi	Faculty - pavement modeling / consumption
Dr. Mike Murphy, P.E	Research Engineer / Configurations / Interviews / Factors
Mr. Robert Harrison	CTR Deputy Director - Economics / Cost analysis
Dr. Hui Wu, P.E.	Research Assistant Configurations / Factors / Safety considerations
Ms. Lisa Loftus-Otway	Legal / Legislative issues
Manar Hasan	MS GRA
Hongbin Xu	Ph.D. GRA
Swati Agarwal	MS GRA

UTSA

Dr. Jose Weissmann, P.E.	Faculty - Bridge analysis / modeling / consumption
Dr. Angela Weissmann	Researcher - Bridge analysis / modeling / consumption

Workshop II Agenda

1. Introduction and purpose of Workshop Presentations — **Mike Murphy**
2. Safety of Life at Sea (SOLAS) rules & international containers — **Robert Harrison**
3. Container Truck SLA Configurations – analysis and discussion — **Jose Weissmann**
4. Ready Mix Truck SLA Configurations – analysis and discussion — **Mike Murphy**
5. Milk Tank Truck SLA Configurations – analysis and discussion — **Mike Murphy**
6. Oil Well Service Rigs – discuss challenges / feedback — **Mike & Jose**
7. Open Discussion – **Mike Murphy, Jose Weissmann, Jorge Prozzi, Robert Harrison**

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Introduction and purpose of Workshop Presentations

1. Ensure consistency of each configuration analysis
2. Present evaluated truck configurations – discuss analysis
3. Ask questions to clarify industry objectives and expectations
4. Obtain feedback from industry regarding additional factors and/or configurations for consideration

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Truck analysis Information that will be presented

1. Description of configurations

2. Pavement and Bridge consumption values
   a) Containers – Statewide, Harris County – 2 analyses
   b) Ready mix trucks – Statewide, Metro counties
   c) Milk Tank trucks – Statewide
   d) Oil well service vehicles
3. Bridge impacts regarding posting requirements (in progress)

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Safety of Life at Sea (SOLAS) Convention

IMPACTS FOR TEXAS LANDSIDE SUPPLY CHAINS

Robert Harrison

SOLAS

- International Maritime Organization (ILO)
- Convention has 162 Signatories
- SOLAS Container VGM laws began July 1 2016
- Requires the shipper recorded on the Bill of Lading to verify the gross mass (VGM) of each loaded containers
- Marine Carriers will not allow a loaded container without a VGM to be moved onboard at the terminal
- Currently daily around 300,000 loaded containers are impacted globally
- Essentially most container terminals in the world (including Houston) have refused to weigh containers on port premises

Highway Enforcement Issues

- Any loaded imported container will have a VGM
- At some point in the supply chain exported containers will need to have a GVM before entering port terminals
- The VGM can be completed in two ways
- Almost all loaded container commodities can be accurately estimated at the point of loading without a truck weigh scale
- The challenge of shippers, dray companies and enforcement is to insure the VGM is adequately distributed across the chassis and tractor while on the highway portion of the supply chain.

Container Chassis and Bridge Consumption

<u>31 Configurations Evaluated</u>

José Weissmann and Angela J. Weissmann

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Data Sources

Federally mandated bridge inventory
BRINSAP/NBI

↓

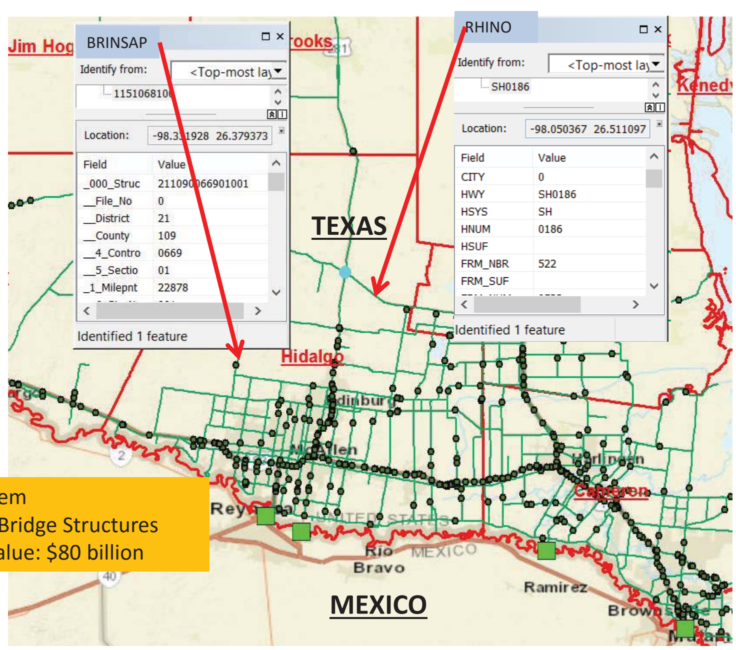
Bridge data
Highway classification
Urban/rural
County

TxDOT’s Roadway Highway Inventory Network
RHINO

↓

Roadway segment mileage
Highway classification
Urban/rural
County

Road Segments and Bridges (GIS System)



On System
22,118 Bridge Structures
Asset Value: $80 billion

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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

- **<u>Objective:</u>** 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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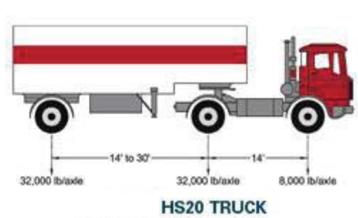
Each Bridge has a Rated Capacity Recorded in the Database (HS Loading)

Inventory Rating
Operating Rating



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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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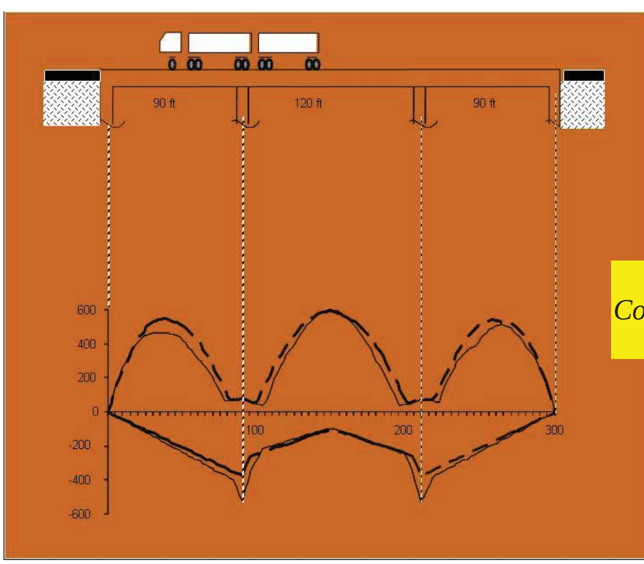
Computerized Bending Moment Envelopes

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



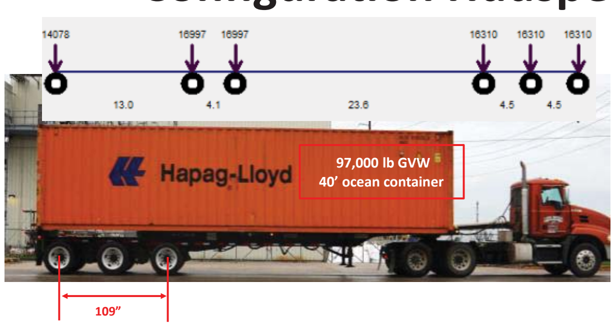
$$ConsumptionRatio = \left(\frac{M_{OSOW}}{M_{Inventory}}\right)^m$$

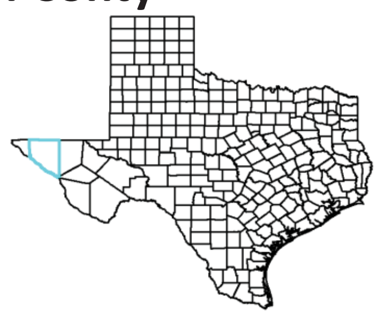
Bridge Consumption – Asset Value

- 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%**

Detailed Results for One Container Configuration Hudspeth Conty





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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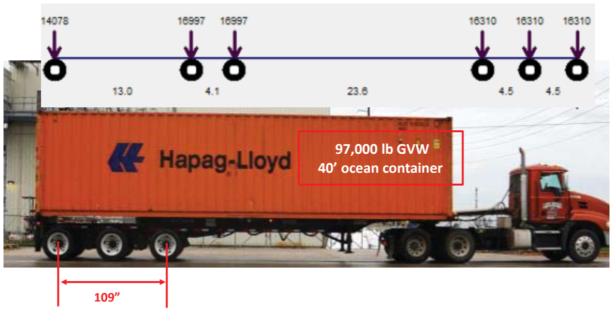
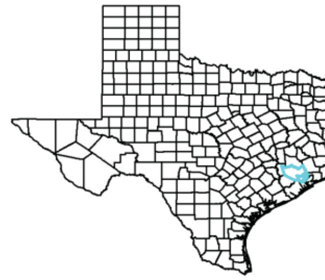
Detailed Results for One Container Configuration Harris County





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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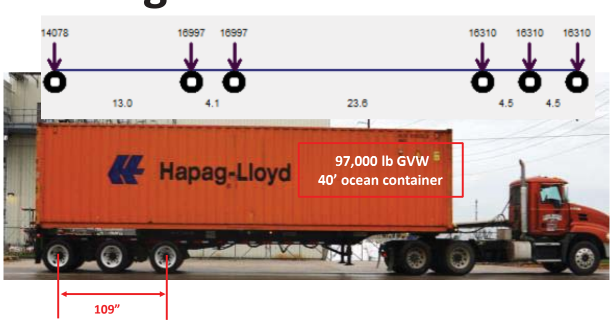
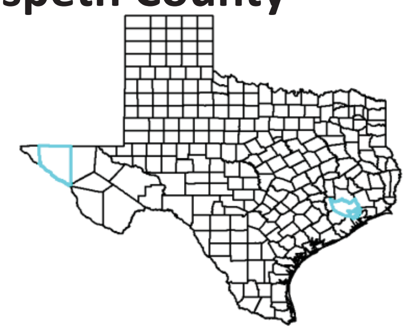
Detailed Results for One Container Configuration Harris vs Hudspeth County





		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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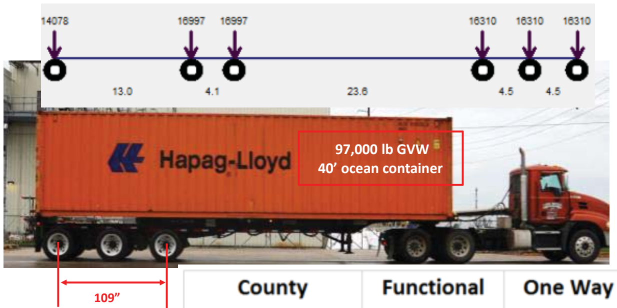
Bridges Expected to be Above Operating Rating Harris County



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 <u>almost</u> 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 vehicle configurations: Container Chassis, Milk Trucks, Ready Mix Trucks.

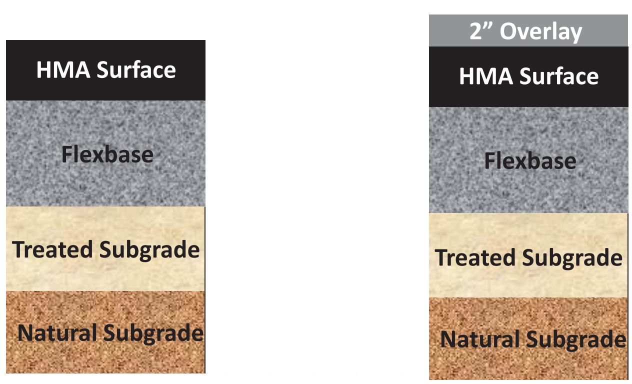
• Results are summarized by county, functional class, urban or rural. Percentages of bridges probably exceeding operating rating are also summarized.

Pavement Consumption Analysis Concepts

- DarWin ME is used to evaluate specific distress types of interest to pavement engineers with regard to axle configurations and loads applicable to this study
- Roughness (IRI), rutting and fatigue cracking were chosen to evaluate consumption
- Each distress type may yield a different consumption rate **$ / VMT** over a 20 year period
- The average consumption **$ / VMT** for roughness, rutting and fatigue cracking was computed

Consumption cost $/VMT using the UT-CTR pavement analysis methods

Calculated based on the additional pavement structure needed to achieve the pavement design life considering increased loads associated with the specific Vehicle configuration



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Ready Mix Trucks

3-axle ready mix truck – State Exemption 69,000 lbs, with permit up to 25,300 lb steer, 50,600 lb tandem

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B*	Summary on Consumption Analysis - Statewide				Summary on Consumption Analysis - Top 20 Counties of Registered Ready Mix Tucks ***			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**	Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
ReadyMix_1-1	**3-axle ready mix truck - 54,000 lb maximum GVW legal load limits**	46,700	16,700	24'	5'	Yes	$ 0.10	$ 0.021	$ 0.121	1.00	$ 0.10	$ 0.121	$ 0.221	1.88
ReadyMix_1-2	3-axle Ready Mix Truck - state exemption of 69,000 lb GVW 23,000 lb steer, 46,000 lb tandem max	63,000	33,000	24'	5'	No	$ 0.29	$ 0.057	$ 0.347	2.86	$ 0.29	$ 0.341	$ 0.631	5.21
ReadyMix_1-3	3-axle Ready Mix Truck - Ready Mix Truck Permit 69,000 lb GVW exemption - (but up to 25,300 lb steer, 50,600 lb tandem)	69,000	39,000	24'	5'	No	$ 0.47	$ 0.085	$ 0.555	4.58	$ 0.47	$ 0.486	$ 0.956	7.89

4-axle ready mix truck (SU 4) proposed weight 70,100 lbs GVW

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B*	Summary on Consumption Analysis - Statewide				Summary on Consumption Analysis - Top 20 Counties of Registered Ready Mix Tucks ***			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**	Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
ReadyMix_2-1	SU-4 4-axle ready mix truck with 1 booster axle - 69,000 lbs state exemption	69,000	38,000	40'	19'	No	$ 0.20	$ 0.046	$ 0.246	2.03	$ 0.20	$ 0.323	$ 0.523	4.32
ReadyMix_2-2	SU-4 4-axle ready mix truck with 1 pusher axle - 69,000 lbs state exemption	69,000	37,000	26'	9'	No	$ 0.28	$ 0.081	$ 0.361	2.98	$ 0.28	$ 0.470	$ 0.750	6.19
ReadyMix_2-3	SU-4 4-axle ready mix truck with 1 pusher axle - 70,100 lbs	70,100	39,100	26'	9'	No	$ 0.31	$ 0.087	$ 0.397	3.28	$ 0.31	$ 0.501	$ 0.811	6.69
ReadyMix_2-4	SU-4 4-axle ready mix truck with 1 booster axle - 70,100 lbs	70,100	39,100	40'	19'	No	$ 0.23	$ 0.052	$ 0.282	2.33	$ 0.23	$ 0.371	$ 0.601	4.96

5-axle ready mix truck (SU 5) proposed weight 70,500 lbs GVW

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B*	Summary on Consumption Analysis - Statewide				Summary on Consumption Analysis - Top 20 Counties of Registered Ready Mix Tucks ***			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**	Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
ReadyMix_3-2	SU-5 5-axle ready mix truck with 1 pusher axle and 1 booster axle - 69,000 lbs state exemption	69,000	35,000	41'	24'	Yes	$ 0.17	$ 0.048	$ 0.218	1.80	$ 0.17	$ 0.332	$ 0.502	4.14
ReadyMix_3-3	SU-5 5-axle ready mix truck with 1 pusher axle and 1 booster axle - 70,500 lbs	70,500	36,500	41'	24'	Yes	$ 0.15	$ 0.051	$ 0.201	1.66	$ 0.15	$ 0.354	$ 0.504	4.16

6-axle ready mix truck (SU 6) proposed weight 75,500 lbs GVW

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B*	Summary on Consumption Analysis - Statewide				Summary on Consumption Analysis - Top 20 Counties of Registered Ready Mix Tucks ***			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**	Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
ReadyMix_4-2	SU-6 6-axle ready mix truck with 2 pusher axles and 1 booster axle - 69,000 lbs state exemption	69,000	36,000	41'	29'	Yes	$ 0.13	$ 0.058	$ 0.188	1.55	$ 0.13	$ 0.399	$ 0.529	4.37
ReadyMix_4-3	SU-6 6-axle ready mix truck with 2 pusher axles and 1 booster axle - 75,500 lbs	75,500	39,500	41'	29'	No	$ 0.13	$ 0.065	$ 0.195	1.61	$ 0.13	$ 0.485	$ 0.615	5.08

7-axle ready mix truck (SU 7) proposed weight 80,000 lbs GVW

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B*	Summary on Consumption Analysis - Statewide				Summary on Consumption Analysis - Top 20 Counties of Registered Ready Mix Tucks ***			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**	Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
ReadyMix_5-2	SU-7 7-axle ready mix truck with 2 pusher axle2 and 1 booster axle - 69,000 lbs state exemption	69,000	34,000	42'	33'	Yes	$ 0.11	$ 0.047	$ 0.157	1.29	$ 0.11	$ 0.329	$ 0.439	3.63
ReadyMix_5-4	SU-7 7-axle ready mix truck with 3 pusher axles and 1 booster axle - 80,000 lbs	80,000	42,000	42'	33'	Yes	$ 0.12	$ 0.066	$ 0.186	1.53	$ 0.12	$ 0.523	$ 0.643	5.30

Ready Mix Truck Analysis

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B*	Summary on Consumption Analysis - Statewide				Summary on Consumption Analysis - Top 20 Counties of Registered Ready Mix Tucks ***			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**	Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
ReadyMix 1-1	**3-axle ready mix truck - 54,000 lb maximum GVW legal load limits**	**46,700**	**16,700**	**24'**	**5'**	**Yes**	**$ 0.10**	**$ 0.021**	**$ 0.121**	**1.00**	**$ 0.10**	**$ 0.121**	**$ 0.221**	**1.83**
ReadyMix 1-2	3-axle Ready Mix Truck - state exemption of 69,000 lb GVW 23,000 lb steer, 46,000 lb tandem max	63,000	33,000	24'	5'	No	$ 0.29	$ 0.057	$ 0.347	2.86	$ 0.29	$ 0.341	$ 0.631	5.21
ReadyMix 1-3	3-axle Ready Mix Truck - Ready Mix Truck Permit 69,000 lb GVW exemption - (but up to 25,300 lb steer, 50,600 lb tandem)	69,000	39,000	24'	5'	No	$ 0.47	$ 0.085	$ 0.555	4.58	$ 0.47	$ 0.486	$ 0.956	7.89
ReadyMix 2-1	SU-4 4-axle ready mix truck with 1 booster axle - 69,000 lbs state exemption	69,000	38,000	40'	19'	No	$ 0.20	$ 0.046	$ 0.246	2.03	$ 0.20	$ 0.323	$ 0.523	4.32
ReadyMix 2-2	SU-4 4-axle ready mix truck with 1 pusher axle - 69,000 lbs state exemption	69,000	37,000	26'	9'	No	$ 0.28	$ 0.081	$ 0.361	2.98	$ 0.28	$ 0.470	$ 0.750	6.19
ReadyMix 2-3	SU-4 4-axle ready mix truck with 1 pusher axle - 70,100 lbs	70,100	39,100	26'	9'	No	$ 0.31	$ 0.087	$ 0.397	3.28	$ 0.31	$ 0.501	$ 0.811	6.69
ReadyMix 2-4	SU-4 4-axle ready mix truck with 1 booster axle - 70,100 lbs	70,100	39,100	40'	19'	No	$ 0.23	$ 0.052	$ 0.282	2.33	$ 0.23	$ 0.371	$ 0.601	4.96
ReadyMix 3-2	SU-5 5-axle ready mix truck with 1 pusher axle and 1 booster axle - 69,000 lbs state exemption	69,000	35,000	41'	24'	Yes	$ 0.17	$ 0.048	$ 0.218	1.80	$ 0.17	$ 0.332	$ 0.502	4.14
ReadyMix 3-3	SU-5 5-axle ready mix truck with 1 pusher axle and 1 booster axle - 70,500 lbs	70,500	36,500	41'	24'	Yes	$ 0.15	$ 0.051	$ 0.201	1.66	$ 0.15	$ 0.354	$ 0.504	4.16
ReadyMix 4-2	SU-6 6-axle ready mix truck with 2 pusher axles and 1 booster axle - 69,000 lbs state exemption	69,000	36,000	41'	29'	Yes	$ 0.13	$ 0.058	$ 0.188	1.55	$ 0.13	$ 0.399	$ 0.529	4.37
ReadyMix 4-3	SU-6 6-axle ready mix truck with 2 pusher axles and 1 booster axle - 75,500 lbs	75,500	39,500	41'	29'	No	$ 0.13	$ 0.065	$ 0.195	1.61	$ 0.13	$ 0.485	$ 0.615	5.08
ReadyMix 5-2	SU-7 7-axle ready mix truck with 2 pusher axle2 and 1 booster axle - 69,000 lbs state exemption	69,000	34,000	42'	33'	Yes	$ 0.11	$ 0.047	$ 0.157	1.29	$ 0.11	$ 0.329	$ 0.439	3.63
ReadyMix 5-4	SU-7 7-axle ready mix truck with 3 pusher axles and 1 booster axle - 80,000 lbs	80,000	42,000	42'	33'	Yes	$ 0.12	$ 0.066	$ 0.186	1.53	$ 0.12	$ 0.523	$ 0.643	5.30

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Milk tank trucks

5-axle tractor trailer 80,000 lb GVW – Configuration 1-1

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B	Summary on Consumption Analysis			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
MilkTank_1-1	**5-axle tractor with 6,300 gallon tank trailer - 80,000 lbs GVW**	**80,000**	**51,500**	**61'**	**44'**	**No**	**$ 0.17**	**$ 0.043**	**$ 0.213**	**1.00**

5% over gross vehicle weight and 12% axle tolerance – Configuration 1-2

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B	Summary on Consumption Analysis			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
MilkTank_1-1	**5-axle tractor with 6,300 gallon tank trailer - 80,000 lbs GVW**	**80,000**	**51,500**	**61'**	**44'**	**No**	**$ 0.17**	**$ 0.043**	**$ 0.213**	**1.00**
MilkTank_1-2	5-axle tractor with 6,500 gallon tank trailer - 84,000 lbs GVW - agricultural exemption (12% tolerance on one tandem)	84,000	54,600	61'	44'	No	$ 0.22	$ 0.052	$ 0.272	1.28

5-axle tractor trailer 90,000 lb GVW – Configuration 2-1

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B	Summary on Consumption Analysis			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
MilkTank_2-1	5-axle tractor with 7,000 gallon tandem axle truck tractor tandem axle tank trailer - 90,000 lbs GVW	90,000	60,000	61'	44'	No	$ 0.28	$ 0.065	$ 0.345	1.62

6-axle tractor tridem trailer 90,000 lb GVW – Configuration 2-2

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B	Summary on Consumption Analysis			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
MilkTank_2-1	5-axle tractor with 7,000 gallon tandem axle truck tractor tandem axle tank trailer - 90,000 lbs GVW	90,000	60,000	61'	44'	No	$ 0.28	$ 0.065	$ 0.345	1.62
MilkTank_2-2	6-axle tractor with 7,000 gallon tridem axle tank trailer - 90,000 lbs GVW	90,000	58,500	66'	49'	No	$ 0.16	$ 0.061	$ 0.221	1.03

6-axle tridem tractor tandem trailer 90,000 lb GVW – Configuration 2-3

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B	Summary on Consumption Analysis			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
MilkTank 2-1	5-axle tractor with 7,000 gallon tandem axle truck tractor tandem axle tank trailer - 90,000 lbs GVW	90,000	60,000	61'	44'	No	$ 0.28	$ 0.065	$ 0.345	1.62
MilkTank 2-2	6-axle tractor with 7,000 gallon tridem axle tank trailer - 90,000 lbs GVW	90,000	58,500	66'	49'	No	$ 0.16	$ 0.061	$ 0.221	1.03
MilkTank 2-3	6-axle tractor with 7,000 gallon trailer tridem axle tractor - 90,000 lbs GVW	90,000	58,500	57'	48'	No	$ 0.24	$ 0.068	$ 0.308	1.45

Milk Tank Truck Analysis Spreadsheet

Truck Configuration ID	Truck Description	Truck Weight and Dimension				If comply with Bridge Formula B	Summary on Consumption Analysis			
		GVW (lbs) *	Payload (lbs)	Outer Bridge (ft)	Inner Bridge (ft)		Pavment Consumption Rate/ VMT	Bridge Consumption Rate/ VMT	Total Consumption Rate/ VMT	Cost Ratio**
MilkTank 1-1	**5-axle tractor with 6,300 gallon tank trailer - 80,000 lbs GVW**	**80,000**	**51,500**	**61'**	**44'**	**No**	**$ 0.17**	**$ 0.043**	**$ 0.213**	**1.00**
MilkTank 1-2	5-axle tractor with 6,500 gallon tank trailer - 84,000 lbs GVW - agricultural exemption (12% tolerance on one tandem)	84,000	54,600	61'	44'	No	$ 0.22	$ 0.052	$ 0.272	1.28
MilkTank 2-1	5-axle tractor with 7,000 gallon tandem axle truck tractor tandem axle tank trailer - 90,000 lbs GVW	90,000	60,000	61'	44'	No	$ 0.28	$ 0.065	$ 0.345	1.62
MilkTank 2-2	6-axle tractor with 7,000 gallon tridem axle tank trailer - 90,000 lbs GVW	90,000	58,500	66'	49'	No	$ 0.16	$ 0.061	$ 0.221	1.03
MilkTank 2-3	6-axle tractor with 7,000 gallon trailer tridem axle tractor - 90,000 lbs GVW	90,000	58,500	57'	48'	No	$ 0.24	$ 0.068	$ 0.308	1.45

7,500 gallon Capacity - tank tare weight 14,365 lbs

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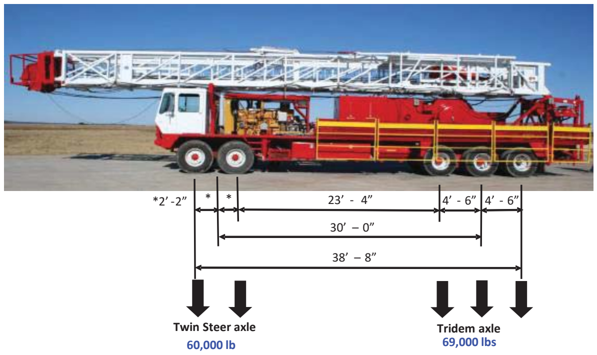
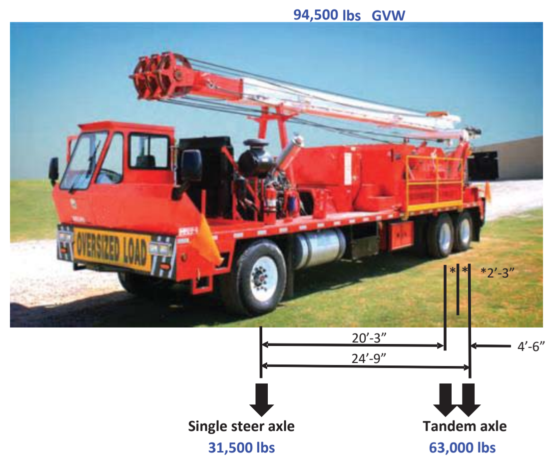
Oil Well Service Vehicles



Configuration	Well Servicing unit descriptions	Estimated % on-system bridges above operating rating
1	**Base case 3-axle unit (Legal Load limit) 54,000 GVW**	12
2	3-axle unit at 90,000 GVW	80
3	3-axle unit at 94,500 GVW	100
4	4-axle unit	100
5	5-axle unit	93
6	6-axle unit	93
7	7-axle unit	72



Discussion

Appendix I: Workshop II Notes

1. Opening remarks

2. Presentations and Discussions

a. Dr. Mike Murphy gave the introduction and workshop agenda, including presenters' names, and the workshop objectives overview.

b. Mr. Robert Harrison talked about Safety of Life at Sea (SOLAS) rules & international containers. From July 1 2016, SOLAS Container VGM laws requires shippers recorded on the Bill of Lading to verify the gross mass (VGM) of each loaded containers. Robert Harrison also discussed the impact on weight enforcement issues.

   Question 1 Area L: Are these containers sealed when they go on ships? Or can weight be added after the ports are shown a document with a certain weight value on it?

   Mr. Robert Harrison: They are sealed, so no one can add further weight.

c. Dr. Jose Weissmann discussed Container Truck SLA Configurations and bridge consumption analysis. 31 configurations have been evaluated. Chassis types and how the containers are put on truck bed impact the results.

   The goal of the bridge analysis is to estimate consumption $ /mile for all bridges and all configurations. Input types needed for the analysis include structural bridge data and bridge asset value, mileage data, and location. The team retrieved inventory load stored in BRINSAP, calculated the moment envelope, and compared it to the load under analysis. Bridge densities are lower in west Texas; Dr. Weissmann discussed how this affects the consumption /mile. He mentioned that summarized results that would be available in the library.

   Dr. Jose Weissmann explained that 3 bridge consumption analyses were performed:

   - Statewide average consumption
   - Harris County – all state maintained functional class routes
   - Harris County – all high functional class routes.

   Dr. Weissmann indicated that bridge density or the number of bridges per mile affects that bridge consumption rate depending on whether the analysis is conducted in a rural county such as Hudspeth or a metro county such as Harris.

   Dr. Weissmann discussed the bridge analysis concepts used to compute consumption on the basis of fatigue stress or bending moment analysis. The statewide analysis is based on travel over all on-system state maintained bridges and the associated route mileage. The consumption information is determined based on the total consumption divided by the route mileage to provide $ / VMT for bridges in each county for each roadway functional class.

A case study was presented for a 6-axle 97,000 lb 40' container and the consumption rates discussed with regard to the differences in bridge densities.

We will be analyzing containers that operate on the West Coast in California and Washington State at heavier weight limits.

Mike Murphy: Regarding the West Coast configurations, we would like to show industry some of the configurations that are being operated to obtain your feedback: A range of photos showing various heavy weight container configurations were shown.

Question 2 **Area C** (Older Gentleman with cane): You want us to tell you what configuration to use? We thought you were going to tell us.

Response: We need to understand if these configurations might present some constraint to your operations since you currently operate different chassis and tractor types. For example, note that many of tractors running on the West Coast are much longer wheel base than we've seen in Houston and often have a lift axle.

The overall tractor - chassis length is greater - could this result in geometric problems inside Barbours Cut as you move from one station to the other in the process of getting your container approved and off loaded for shipment? Thus the question of configurations that work not only applies to load, but also geometrics turning radius and potentially other factors.

We can analyze these configurations for axle and gross vehicle weights considering 97k, but will that configuration work for you?

Question 3 What factors are you considering when looking at these configurations; ……load?

Mike Murphy Response: As Dr. Weissmann, Dr. Prozzi and I have discussed, we are looking at every configuration in terms of pavement consumption, bridge consumption and number of bridges that would require posting depending on the functional class system.

Question 4 Trucking Industry-- It is really chicken or the egg. We need to know what you are recommending so we can determine if that will work for us or not. What direction have you been given from the legislature?

Dr. Mike Murphy: Determine configurations that will minimize impacts to infrastructure ($/VMT) and minimize impacts for potential bridge postings.

Trucking Industry: You should go ahead and look at what they are running on the West Coast and include your recommended configurations in the analysis.

Response: We will continue to examine the different configurations and chassis designs to arrive at some general recommendations for lower $/VMT configurations with lower bridge posting issues.

d. Dr. Mike Murphy briefly discussed that previously, pavement designers had relied on the Equivalent Single Axle Load concept developed at the AASHO roadtest to determine required pavement thickness. The ESAL and the concept of serviceability were developed at the Road Test; serviceability essentially is pavement roughness which is the primary factor used by the public to evaluate how good a job the DOT is doing. However, the ESAL concept is complex and not easy to explain to the public. In addition, pavement engineers are interested to know about other distresses such as rutting which is an indicator of structural problems and a safety concern due to hydroplaning the pavement consumption models which are based on 3 failure criteria: International Roughness Index (IRI), rutting, and fatigue cracking.

e. Dr. Mike Murphy presented Ready Mix Truck SLA Configurations and consumption analysis results for both bridges and pavement. He mentioned that the total number of ready mix trucks is decreasing (11,000 at the time of the Rider 36 Study and ~ 9,200 now in Texas) and this was due to Ready Mix companies updating their fleet to newer, more fuel efficient trucks. Though the trend is still decreasing, based on a discussion with a major Ready Mix supplier, the trend will bottom out and the number of ready mix trucks in Texas will increase in the future. The construction industry is very strong in Texas compared to other states.

f. CTR team used Load Xpert software to make sure the trucks are properly configured, and the loads are properly distributed among axles/ axle groups for the configurations included in the library.

   Ready mix trucks can carry up to 69,000 lb GVW under the state exemption. UT-CTR examined the TxDMV 2060 overaxle weight tolerance permit database and found that only about 3% of permits are sold to ready mix companies. A new permit for 3-axle ready mix trucks was authorized during the last legislative session with allows 3-axle ready mix trucks to operate with up to a 50,600 lb tandem or 25,300 lb steer. Axle. Based on the UT-CTR analysis we were unable to achieve the legal 54,000 lb limit for a ready mix truck considering how the load is transmitted from the drum to the chassis through pedestals at the impeller (front) and roller bearing (rear) sections of the truck; the

3-axle truck maxed out at 34,000 lbs on the tandem before reaching 20,000 lbs on the steer axle. The same was true when evaluating the ready mix truck at 69,000 lbs GVW, the tandems maxed out at 46,000 lbs and was only able to achieve 63,000 lbs GVW. It was only when the new 3-axle ready mix truck permit was applied that a 3-axle ready mix truck could achieve 69,000 lbs GVW.

Additional analyses were performed for the SU4 (4-axle) 70,100 lb, SU5 (5-axle) 70,500 lb, SU6 (6-axle) 75,500 lb and SU7 (7-axle) 80,000 lb GVW ready mix trucks proposed under a previous bill. Each ready mix truck configuration, including the 3-axle trucks were evaluated for statewide, and the top 20 counties in terms of registered ready mix trucks (which comprise over 80% of all registrations) for pavement and bridge consumption. The consumption rates are much higher in the 20 counties which are predominately metro and thus have high bridge densities.

The team has visually observed over 34,000 trucks statewide to determine fleet compositions within metro and urban areas and along routes connecting these cities. We also have obtained 2-hr samples of truck data in multiple locations including ready mix plants, material plants, landfills and so forth.

From the observation, there are a greater number of 3-axle ready trucks than SHVs and it has been noted that some companies only operate 3-axle ready mix trucks. Based on a discussion with a major ready mix supplier, their fleet is composed of 60% 3-axle trucks and 40% SU5s; they have no current plans to purchase SU6s or SU7s. Based on statewide data collection we have observed a few SU6s operating in the Houston area but have not seen SU7s.

Question 5 **Area D:** what is the relevance of the results to industry? What is an acceptable level of the consumption rate?

Dr. Mike Murphy: We investigate the relationships between trucks operating at the current legal load limits and proposed heavier trucks. We provide information about the consumption rates of legal trucks as the ‘base line’ and the consumption rates of the heavier trucks to compare consumption ratio to standard trucks. The baseline truck has a cost ratio of 1.00; a configuration with a cost ratio of 2.00 has twice the consumption rate.

This analysis is contracted by TxDOT State Legislative Affairs and will be used by TxDOT and used to inform legislative policy makers on request. We are meeting with representatives of the trucking industry now to obtain your feedback on the analysis to ensure that we are not missing any important factors. You will be provided with this same information for your use in discussing proposed legislation.

The University does not make policy decisions or recommendations. Our responsibility is to ensure we are evaluating configurations accurately, consistently and are taking into account all of the flexibility that the trucker has in adjusting loads to be legal. When we are analyzing a configuration, our goal is to achieve distribution of the load among the axle groups to meet the FBF requirements and then to achieve the minimum consumption rates.

We are asking the industry to ensure we are on target and getting input in case we are missing something.

Blake Calvert: TxDOT SLA must provide what it will cost the state to run these trucks and still keep roads safe for the truckers and other road users. Fees are up to the legislature. The goal is to estimate the true cost and what are the impacts. What they decide to do at the Capitol with these studies is not our task. We are arming them with the best information possible as a state agency.

<u>Question 6</u> Rich Szecy – Texas Aggregates and Concrete Association **(**asked for clarification) when SU4 goes up to SU5, there's only a 400lb increase in the max weight?

Dr. Mike Murphy: Correct. However, keep in mind that we were unable to determine how to configure an SU4 either with a single pusher or booster axle and meet FBF requirements. The SU5 adds an additional axle and is FBF compliant.

Rich Szecy: What is the difference in consumption?

Dr. Mike Murphy: adding an axle reduces the consumption rate by about 10¢/VMT.

<u>Question 7</u> Mark McDaniel asked: how are you determining whether a triple axle will be 17-17-8 or 14-14-14 (weight distributions)?

Dr. Mike Murphy: We're analyzing the configurations according to what we see in practice. The state legal tridem axle load is 42,000 lbs and the assumption is that the load is equally distributed among the 3-axles (14, 14, 14); however on a ready mix truck, the additional lift axle is not set by load, the operator reads a chart on the truck and sets the lift axle airbag pressure depending on the number of CY the truck is carrying. Thus, a tridem on a ready mix truck typically has a lower load on the pusher than the fixed tandems; but this varies: when a booster axle is lowered the axle load distributions can change. However, as mentioned before during the discussion about the 3-axle trucks we may be missing something, so if any of the trucking industry representatives knows differently, please don't hesitate to help us out.

<u>Comments</u>

Dr. Mike Murphy: The study determines bridge-formula-compliant configurations that are realistic, and then the configurations were sent to pavement and bridge analysis. The objective here is to get your input and see if we are missing something when coming up with configurations for analysis.

Blake Calvert: We are trying to create an open line of conversation between TxDOT, researchers and industry. If you have a configuration you want to run, we can analyze it.

g. Dr. Mike Murphy showed Milk Tank Truck SLA Configurations and consumption analysis results for both bridge and pavement. The milk tank truck analysis only considered statewide values – we know where the dairies and processing plants are located but the operations are over longer distances thus we cannot; at present, determine the routes along which milk tankers operate. I've seen them on US 281, US 183 and on IH 35.

Question 8 Dr. Mike Murphy: Is the industry interested in raw milk pickup tankers or sanitary food grade tankers?

Areas B and C: milk industry is interested more in the sanitary food grade milk tankers, as they had not seen the other type very often outside farms.

Question 9 Area C: We've recently read that federal law now allows milk to be considered a non-divisible load so that trucks can run at full tank capacity on the Interstate; 17 states were previously allowed this exemption), but now Texas has been included so we can operate heavier milk tankers on interstate highways. Are the standards for IH the same, and did you take this into account in your analysis?

Dr. Mike Murphy: IH's can vary from region to region due to soil, climate, traffic loading and other factors. For example in Houston about 60% of their network is Continuously Reinforced Concrete Pavement, while IH 35 in Austin is primarily flexible pavement. There are sections of IH 10 headed toward El Paso that are actually surface treated pavements due to lower truck volumes. Thus if industry wants to operate along specific Interstate Routes it would be best to provide Blake with the routes that are of interest.

Question 10 Area C: Are you also considering county roads in your analysis?

Dr. Mike Murphy: This analysis is for on-system roadways and bridges, and does not include county roads. But we can provide results for a certain highway classes.

Question 11 Area C: (older gentleman with a cane) So you are letting the counties figure out how to handle heavier trucks themselves?

Dr. Murphy: Our contract with SLA is to evaluate the Texas on-system network. In any case, counties typically do not have the type of details for pavements that would be necessary for the analyses we perform; TxDOT has pavement information stored in their Pavement Management Information System and we can access plan sets to obtain information about pavements along specific routes. TxDOT is responsible for maintaining the bridge inventory database statewide, local county government typically does not have the staff to perform bridge inspections or to collect and manage the data that is needed.

Dr. Jose Weissmann: Bridge results by highway class are already in the library.

Dr. Prozzi and Dr. Murphy: Give us routes, guidance, weight limits, etc. (through Blake), and we'll try our best.

h. Dr. Mike Murphy and Dr. Jose Weissmann talked about challenges for Oil Well Service Rigs analysis. Special trip-based permits are sold for Oil Well Service Rigs with high GVW. Heavy loads and a high percentage of the bridges would have to be posted if the operations were to be continuous. We did not calculate consumption for these cases.

These trucks are very expensive. Some very old oil well service rigs are still operating though the original company that built them is no longer in service. This means that the information about weights, wheel bases and other factors may be hard to find. New units have completely different configurations and we are able to obtain factory brochures and information to properly analyze these rigs. We would like to know what configurations the industry is most interested in.

Question 12 Area K: Some configurations are above operating rating for all bridges. How do they get special permits?

Dr. Weissmann: Operating rating is when you allow unlimited operations. When it is a one-time pass, the bridge division does a detailed analysis of the route and decides if the once in a while pass can be permitted or not.

Question 13 Area J: Trent Thomas The slide shows there isn't a single on-system bridge that this could go across? How does that work?

Dr. Weissmann: There's a significant difference between continuous usage and one-time. Continuously, these loads over these bridges would be a problem, but it's a different story if it's routed.

Note: After the Workshop, Rich Szecy spoke to Dr. Murphy and advise him that he was the industry representative that submitted the bill based on the needs of a single company – however, that company is now bankrupt – and other oil field industry leaders didn't understand what this company was trying to achieve. You can forget about this issue.

3. Open Discussions

Question 14 Dr. Mike Murphy: Is there any other potential type of trucks that industry are interested in? What I mean is, to prepare for the next legislative session, are their other industries (different commodities) that may submit bills requesting higher weight limits?

Area V: We think Mobile Cranes are something that are of interest, as well as the TX Crane Owners Association, and we would like to add to the discussion. There's been lots of changes in this field, with new technology and other things, and we'd like to be a part of this.

Dr. Murphy: Great! Please send information to Blake. Also, just to clarify, were you interested in the large mobile cranes – I saw a 6-axle Liebherr on IH 35 this morning along with about 5 5-axle step deck support trucks; or are you also interested in truck cranes? By truck cranes, I have seen standard 3-axle SHV and twin steer trucks with a crane mounted – these are quite different from a mobile crane.

Area V: Both.

Dr. Prozzi: We need to work closely with industry contacts, especially for the mobile cranes because of the uniqueness of the tires.

Josh Winegarner – Texas Cattle Feeders Association: We are interested in heaver trucks for livestock and grain. We will be more competitive with other states if we can haul heavier loads within Texas and across state lines. Other states have higher weight limits for livestock trailer for example.

Mike Murphy: Can you provide specifics? I have collected site data at the Junction of US 287 and IH 44 in Wichita Falls and have seen livestock trailers running between Amarillo and Ft. Worth. Where do these trucks primarily run?

Josh Winegarner: I can take you outside town here in Austin and show you where livestock trucks are running.

Mike Murphy: In order to do the analysis we need specifics. I've seen 2 level livestock trucks and single level livestock trucks – are you interested in the same weight limits for both?

Jose Winegarner: The single level trailers are for heavier cows and bulls. The two level trailers are for smaller, feeder cattle; we likely would want different weight limits for the different trailers. Probably somewhere between 90 – 95,000 lbs.

Mike Murphy: In order to perform the analysis we will need specific weight limits for each configuration – it is too complicated and too many variables for us to consider a weight range for a specific configuration.

Josh Winegarner: I'll talk to our people and we will provide you with specifics.

Mike Murphy: Are the trailers you are currently using able to carry more cows – you are just maxing out on legal load?

Josh Weingarner: That's correct, we could carry more cows in the trailers we already have.

Mike Murphy: Please send them to Blake, he will review them and send the proposed analysis to us……but keep in mind, this contract ends in October.

Dr. Mike Murphy: Another factor is that I've seen tandem axles on livestock trucks spaced at 54" and split tandems at 109" I've never seen a tridem axle livestock truck in Texas – would industry support a tridem livestock trailer/

Josh Winegarner – As was already said – the trailer manufacturers will build whatever we ask them to build – but the law has to be in place before we make the investment – you haven't seen any tridem livestock trailers in Texas because there's no incentive.

Mike Murphy: What about the grain trailers – what configuration and weight limit?

Jose Winegarner: Likely a similar weight limit to the Livestock trailers – we are talking about the hopper type trailers.

Rob Harrison – the hopper trailers are very efficient and are already in operation. Essentially, the truck drives over a grated system, opens the hopper and the grain drops into a collection system which transports it to the silo.

Dr. Mike Murphy: I've seen these types of grain trucks, but I've also seen live-bottom units that dump out of the back. The only reason the operations of the trailer is important relates to the tare weight of the trailer. If you are using both belly dumps and belt trailers, we need to know.

Josh Winegarner: I'll ask this question.

Question 15 Colin Parrish: I will not talk about the policy aspects of it, since that isn't your call. In this presentation, the results of this analysis give a $ value, that says is assigning VMT fee in comparison to standard truck. However, it doesn't take the commodity (or its value) into account. Also, wouldn't the increase in the max weight allowed result in a reduction of the number of trucks out there? I suggest to assign a reduction rate because there will be less trucks.

Dr. Murphy: We weren't tasked with answering that question. Response: We discussed the fact that projecting the potential impacts to changes in truck size and weight are difficult at best.....in most cost allocation studies there is not an adjustment made for potential reductions in number of truck loads. A law that allows increased truck weights might attract new business and increase the number of containers moving at Houston or along IH 45 / IH 10.

In fact, right now at 80,000 lb GVW, I've seen many flat beds and car transporters running empty or with partial loads – would an increase in weight limits change their operations?   We can't see if ready mix truck is running fully loaded – though based on the National Concrete Ready Mix Association annual survey the average load is 9.3 CY. Based on our evaluation of ready mix trucks for sale in Texas 3-axle trucks typically have 10, 10.5 or 11 CY drums. SHVs invariably have 11 CY drums.

Dr. Prozzi: We were tasked with evaluating the costs, not the benefits. This analysis still needs to be done. The cost is a unit cost. When you calculate the total number of trips you can factor this benefit. Dr. Prozzi gave a simple example of how the industry can account for the truck reduction using the unit costs provided.

Dr. Prozzi – we are investigating a different statistic in project 0-6817, consumption per unit lb.   We will be holding workshop for 0-6817 this afternoon at CTR from 2:00 pm to around 4:30 PM and would like to invite all of you to attend if your schedule permits.

Mr. Robert Harrison: Larger trucks impact all the transportation modes. For example, history shows that heavier trucks, because they are more competitive on a ton-mile basis, impact rail shares on key routes. There is a bigger question about whether or not the state should allow higher productivity for one mode at the expense of a competitor.

Area I (Rail Industry): You're talking about a drawn out analysis over time, but this is a static snapshot analysis. How do you propose they do what you're asking?

Mr. Robert Harrison: We're only looking at one mode in the entire transportation system in this project. TxDOT is concerned about its assets and the marginal impact of allowing more productive trucks to use its system. However, in response to the reduction in truck issue, looking historically, whenever the truck weight limits were increased the number of trucks actually grew in the long term. There have only been two Class 8 GVW increases in over 50 years, one to 72,000 lb. in the early 1970s and a second to 80,000 lb. in the early 1980s Rail lost market share in key areas where distance was less than 800 miles. The one important sector is domestic intermodal where rail and trucking companies have developed a successful joint business strategy.

Blake Calvert: When the legislature asks SLA to comment on a fiscal note we provide the unit cost. The trip reduction requires a lot of assumption we have not data to make.

Mark McDaniel: You're all referring to two different types of analyses. We do keep the reductions in mind in that second type of longer time-span analysis. We studied this issue (truck reduction) and found that it depends on the industry.

Question 16   Colin Parrish: This analysis assigns a dollar value per mile. The analysis itself has lots of underlying assumptions. Would it be better if a ratio was presentation to policymakers instead of a $/mile value? A ratio that takes both costs and benefits into account?

Dr. Murphy: TxDOT is not even receiving gas tax and registration revenue equivalent to the consumption of an 80,000 lb GVW truck; so a question we have is should the ratio be determined based on the consumption of an 80,000 lb GVW truck even though TxDOT does not receive this much in revenue, or should it be based on the actual revenue TxDOT is receiving?

Question 17 Area L: So what this meeting is all about is the permit fee for these trucks?

Dr. Mike Murphy: No, the University does not get involved with making policy - we advise or answer questions posed by TxDOT Administration and the State Legislature, we answer questions they ask. On the basis of this information, the Legislature makes policy decisions considering other factors beside the consumption analysis.

Question 18 Area L: Did it ever occur to you that the benefit to the state that the legislature places on the heavier truck weights is the difference between the revenue TxDOT receives and what you are calculating as the consumption rate?

Mike Murphy: That is a very interesting idea and not one we've considered before. We will study this idea in more detail – this a very intuitive idea.

Blake Calvert: We want to work proactively with the trucking industry, Texas Department of Motor Vehicles and the University to provide you with the same information TxDOT will have in hand when the legislators begin submitting bills in November. It is our intent that we work together proactively to identify the most efficient configurations prior to the beginning of the Session in January to streamline the process.

Question 19 Trucking Industry: When will the final analysis be provided to us?

Response: We will be working on the additional container configurations between now and the end of the contract (October, 2016) and will work to include other types of trucks that have been proposed during this workshop (high weight milk tankers, livestock trailers, grain haulers, mobile cranes).

Blake Calvert: Again our goal is to be ready when bills are filed in November, we will send the final draft of the library just prior to filing. It is yet to be seen if the contract will be extended beyond October.

Question 20 James Terrell: The results of your analyses so far seems like adding an axle doesn't significantly affect the consumption rate. So, what if we went higher? Just giving you a heads-up, but the milk industry might be looking to go higher and seeing what that does. We'd be interested in analyzing 100k. Michigan does it, and we want to look at them.

Dr. Murphy: Some states have grandfather laws allowing them to carry more. If you have specific interest in any truck configuration, please submit it to Blake.

James Terrell: In your analyses, did you see an upper limit of weight on these milk tankers?

Dr. Murphy: That's very complex, since it would depend not just on the higher weight, but also the way it was configured and distributed. But if there's a certain configuration industry has in mind, please forward it to Blake.

Question 21 Dr. Murphy asked question about west coast containers and container corridors. There was one representative (Area AC) interested in container trucks.

Trucking industry: What are the simple differences between the straight truck and the container?

Dr. Murphy: Laws, since there are laws that categorize ocean containers as non-divisible loads, thereby giving it different limits. Federal allows each state to enact legislation about whether or not a container is an indivisible load.

Question 22 Tonia Norman: do we have any data about impacts of these west coast trucks on their infrastructure?

Dr. Murphy: No, we'd need to look into that.

Tonia Norman: These states chose to do this, so maybe they did it for a reason, we could see and learn. Industry may want to know which configurations work best for Texas.

Dr. Murphy: the industry has to work with researchers in this. For example, we can spend time on a container configuration that does not damage the roads and bridge but may be impossible to maneuver inside the port facilities.

Colin Parrish: I think the market will eventually decide on its own what it wants to do long term, but is a part of this project you finding some guidance on ideal configurations? That might help.

Question 23 Area C: Would adding lift axles always reduce consumption rates?

Dr. Murphy: There are many factors, such as if the lift axle is positioned correctly, but yes, it does have the potential, because of weight spreading.

Area D**:** Sometimes adding lift axles can make the situation worse.

Dr. Murphy: Correct, depends on the center of gravity and other factors.

Question 24 Area AC: Were there VMT assumptions made during this analysis? Are you assuming any numbers for the total VMT overall?

Dr. Murphy: We have not been tasked with estimating total VMT.

Question 25 Area AC: Has the container consumption analysis done for state-wide? What's a realistic timeline for the completion of the analysis?

Blake Calvert: The researchers have a lot on their plate, but we imagine sometime in the next couple of months.

Question 26: James Terrell: Is there a time limitation of the contract that industry should be aware of?

Blake Calvert: End of October for this contract. Right before the election. It is undecided whether or not to extend.

The Research Team asked the following questions but got no responses from the audience:

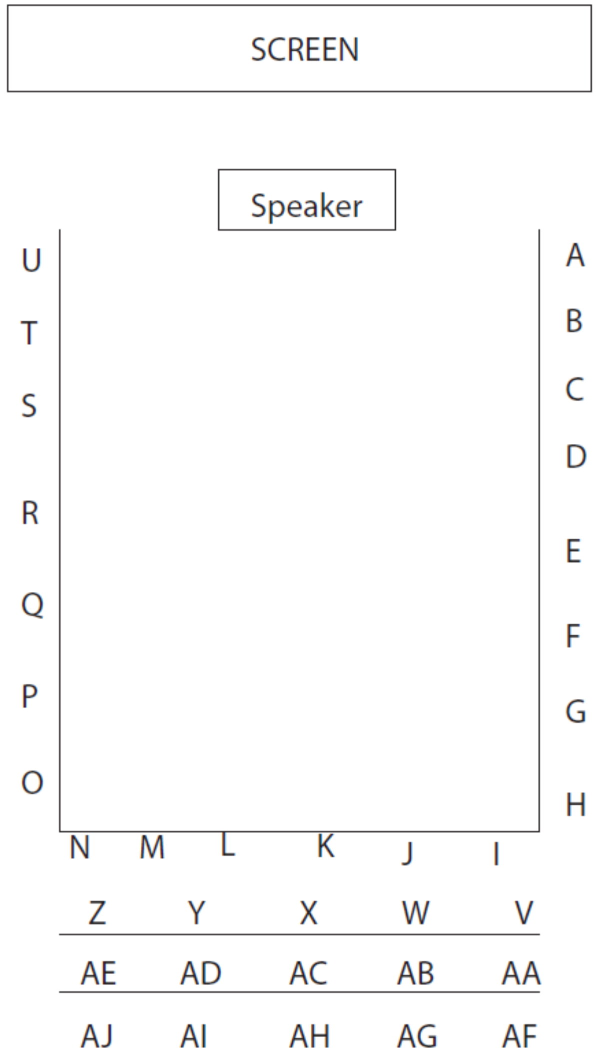
1) How many overweight containers do you expect to move annually (total and/or by a annual permit).

2) How many VMT (Vehicle Miles Travelled) do you currently operate in Houston (short haul) or IH 45/IH 10 (long haul)

3) The National Concrete Ready Mix Association conducts an annual Industry survey regarding ready mix truck operations which provides a wealth of information to their members and those involved in truck size & weight analyses. For example they provide the average mpg for a loaded ready mix truck, the high estimate and the low estimate mpg. Similar information would be helpful for containers and other truck types under consideration.

4. Blake Calvert concluding remarks.

Notes may refer to people without names, identified by general seating area, corresponding to the following diagram.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