

MnROAD [Safer, Smarter, Sustainable Pavements through Innovative Research]

MNROAD SEMI TRACTOR TRAILER

MnROAD Operations – General Description

MnROAD uses a 5-axle semi to provide the loadings to its low volume road (LVR) and provide a known dynamic load to test the dynamic sensor instrumentation. MnROAD's LVR is a 2-lane, 2 ½-mile closed loop that contains many different types of pavements. Traffic on the LVR is restricted to a MnROAD operated vehicle, which is an 18-wheel, 5-axle, tractor/trailer with two different loading configurations. The "heavy" load configuration results in a gross vehicle weight of 102 kips (102K configuration) and the "legal" load configuration has a gross vehicle weight of 80 kips (80K configuration). A Mn/DOT employee drives the MnROAD truck during his normal 8 hour working day averaging around 6 hours of driving or 80 laps a day. Laps are documented by the operator and entered into the MnROAD database. MnROAD does have the ability to track the truck using GPS antennas, which is typically used when collecting dynamic sensor data when location accuracy is required.



MnROAD Mack Tractor with light configuration

MnROAD USED THE FOLLOWING TRAFFIC PATTERNS

This results in a similar number of ESALs being delivered to both lanes even though the number of passes differs. From this point forward, loading on the LVR will be done exclusively by the 80K truck five days per week on the inside lane.

The LVR loading vehicle started operation on June 16, 1994 at the Mn/ROAD Low Volume Road Facility.

COLLECTION FREQUENCY



MnROAD is a state of the art cold weather pavement and transportation testing facility located in Minnesota

80kip truck 5 days per week on the inside lane.

SUMMARY OF THE TRUCK WEIGHTS

Mack in the light configuration

Timeframe	Total Weight (lbs)	Steering Axle	Front axle Tractor tandem	Back axle Tractor tandem	Front axle Trailer Tandem	Back axle Trailer Tandem
June 15, 1994	79,500	12,000	16,900	16,600	15,600	18,400
Present			33,500		34,000	

Mack in heavy configuration

Timeframe	Total Weight (lbs)	Steering Axle	Front axle Tractor tandem	Back axle Tractor tandem	Front axle Trailer Tandem	Back axle Trailer Tandem
June 15, 1994	102,600	13,200	21,000	20,600	22,700	25,100
March 29, 1995			41,600		47,800	
June 15, 1994	102,800	13,600	22,300	21,400	23,900	21,600
March 29, 1995			43,700		45,500	
March 30, 1995	102,600	12,400	22,900	22,200	21,200	23,900
			45,100		45,100	

Navistar in the light configuration

Timeframe	Total Weight (lbs)	Steering Axle	Front axle Tractor tandem	Back axle Tractor tandem	Front axle Trailer Tandem	Back axle Trailer Tandem
June 15, 1994	79,100	11,500	16,900	16,600	16,500	17,600
Present			33,500		34,100	

Navistar in the heavy configuration

Timeframe	Total Weight (lbs)	Steering Axle	Front axle Tractor tandem	Back axle Tractor tandem	Front axle Trailer Tandem	Back axle Trailer Tandem
June 15, 1994	102,400	12,400	21,400	23,400	22,100	23,100
Present			44,800		45,200	

Minnesota Road Research Project – Low Volume Road Traffic Testing Vehicle

The primary vehicle used for the loading of the low volume road will be a 5-axle semi tractor-trailer with a gross weight of as much as 102,000 lbs (kN). The vehicle is equipped with such features as a moveable fifth wheel, sliding rear tandems and a hydraulic crane, which will allow researchers to vary load configurations. Some of the other features are presented below.



TRACTOR

The tractor is a Mack Model RD600S powered by an E7-300 engine, which generates 300 h.p. @ 1950 r.p.m. The HT750DR 5-speed Allison transmission delivers power to the tandem drive axles fitted with dual 11R24.5 tires filled to 100 psi (689 kPa). Fuel is stored in two 110-gallon (416 L) STL fuel tanks. The fifth wheel is air controlled, allowing the trailer to be slid in either direction. The environmentally controlled cab is fitted with two Air-Bostrom 914 Hi-Back seats that can be positioned pneumatically. Another driver-oriented feature is the Model 2406 Collimator Sight. The sight provided the operator a virtual image at a target point, combining the image and field view by utilizing a light source, a lens and a reflector plate. The image may be brightened to compensate for varying atmospheric conditions or for the operator's comfort.

TRAILER

The trailer is a 50 ton (445 KN) rated flatbed which is 45' (13.7 m) long and 96" (2.43 m) wide. It is fabricated of steel framework with an apitong wood floor and has sliding rear tandems, which are also fitted with dual 11R24.5 tires. The trailer is equipped with a hydraulic crane, which facilitates loading and movement of the 1,000-lb (4.448 KN) steel weights used to load the vehicle. The crane can be operated either manually or with a wireless remote unit.

TIRES & TIRE PRESSURE

Starting in June 1994, the Mack was running Michelin radials at 115 psi. New Michelin radials were installed at 16788 miles (12/30/94) and the tire pressures were changed to 100 psi. Recapped Michelin radials were installed at 27567 miles (7/27/95) and continued with a tire pressure of 100 psi. The Navistar truck started running at the LVR facility on September 26, 1994 with an assumed initial tire pressure of 115 psi. On December 30, 1994, the tire pressure switched to 100 psi on the Navistar as well as the Mack. The Mack is currently running Michelin XDAM&S 11R24.5 tires. The trailer is currently running recapped Michelin XZY 11R24.5 tires. The Navistar is currently running Goodyear radials.

TRAILER TANDEM DOLLY & TRACTOR & FIFTH WHEEL POSITIONS

There are 10 positions to which the trailer tandem dolly can be adjusted. For the purposes of this document, the most rearward position is referred to as position #1 and most forward position is referred to as position #10. The "yellow" position is marked with yellow paint and is in position #3. The "white" position is marked with white paint and is in position #2. The holes used to position the trailer tandem dolly are 6 inches on center.

The Mack fifth wheel has always been in the same position, position #4. There are 12 positions, position #1 being the most rearward position and position #12 being the most forward position. There are 12 positions for the Navistar fifth wheel. The "yellow" position is marked with yellow paint and is in position #6, if we call the most reward position, position #1. The "white" position is marked with white paint and is in position #5.

Included herewith are schematics of the weight configurations to be used in the 80 kip and 102 kip configurations. These configurations have been used with the exceptions of the trailer tandem dolly position (changed at the October 6, 1995 weighing), and the movement of the weights which was implemented at the March 28, 1995 weighting.

DOCUMENTATION OF AXLE LOADINGS

This document summarizes the history of the LVR loading vehicle weight configuration and axle weights and offers a method of estimating the axle weights of modified weight configurations without actually weighing the truck.



DOCUMENTATION OF AXLE LOADINGS (OCTOBER 21, 1993)

The first truck weighing took place on October 21, 1993, at the St. Croix weigh station. The total number of weights was recorded as 47 (one thousand pound weights), although the location of the weights was not recorded. It is not known what the fuel level was in the truck's fuel tanks. The axle weights are as follows (Mack in the light configuration):

Steering axle	12000 lb
Front axle of the truck tandem	17480 lb
Back axle of truck tandem	17220 lb
Combined trailer tandem	<u>37100 lb</u>
TOTAL	83800 lb

DOCUMENTATION OF AXLE LOADINGS (NOVEMBER 8, 1993)

The second weighing of the truck was on November 8, 1993, at the St. Croix weigh station, again with the Mack in the light configuration (47 weights). A passenger was in the tractor at this weighing, it is not known what the fuel level was in the truck's fuel tanks. The axle weights are as follows:

Steering axle	12300 lb
Front axle of truck tandem	17740 lb
Back axle of truck tandem	17200 lb
Front axle of trailer tandem	16340 lb
Back axle of trailer tandem	<u>21260 lb</u>
TOTAL	84840 lb

DOCUMENTATION OF AXLE LOADINGS (JUNE 22, 1994)

The next truck weighing took place on June 22, 1994. No useful information from this.

DOCUMENTATION OF AXLE LOADINGS (FEBRUARY 24, 1995)

The next truck weighing took place at the Dayton Port weigh station on February 24, 1995. Only the Mack in the heavy configuration was weighted. The truck's fuel tanks were full. It is known that all 65 one thousand pound weights were used, the locations of the weights were not recorded and the trucks fuel tanks were full. The axle weights follow:

Steering axle	13060 lb
Combined truck tandem	40580 lb
Combined trailer tandem	<u>48920 lb</u>
TOTAL	102560 lb

DOCUMENTATION OF AXLE LOADINGS (MARCH 28, 1995)

The Mack in the heavy configuration was the subject of the next truck weighing, which took place on March 28, 1995 and was performed at the Dayton Port weight station using portable scales. Dave Van Deusen recorded the results of this truck weighing in a memo dated March 30, 1995. A slight modification of the loading configuration was made at this time and Dave included a diagram of the heavy load configuration and an explanation of the changes that were made to the configuration. I



assume from the axle weights that the truck's fuel tanks were full. The axle weights before the change in the loading configuration are as follows:

Steering axle	13200 lb
Front axle of truck tandem	20950 lb
Back axle of truck tandem	20550 lb
Front axle of trailer tandem	22700 lb
Back axle of trailer tandem	<u>25100 lb</u>
TOTAL	102500 lb

The axle weights after the change in the loading configuration are as follows:

Steering axle	13600 lb
Front axle of truck tandem	22250 lb
Back axle of truck tandem	21350 lb
Front axle of trailer tandem	23900 lb
Back axle of trailer tandem	<u>21550 lb</u>
TOTAL	102650 lb

The next truck weighing session involved the Navistar in both the light and the heavy configurations and took place on May 11, 1995 at the Dayton Port weight station. The station's plate scales were used, these scales have been described to me as "not as accurate" as the portable scales used by Dave Van Deusen in the weighing of March 29, 1995. The fuels tanks were full. The results for this truck weighing are recorded in a memo from Jack Herndon to Glenn Engstrom dated May 24, 1995. It is known that there were 42 weights in the light configuration and 65 weights in the heavy configuration. The axle weights for the light configuration are as follows:

Steering axle	11540 lb
Front axle of truck tandem	17300 lb
Back axle of truck tandem	17080 lb
Front axle of trailer tandem	14460 lb
Back axle of trailer tandem	<u>18780 lb</u>
	79160 lb

The axle weights for the heavy configuration are as follows:

Steering axle	11500 lb
Front axle of truck tandem	22820 lb
Back axle of truck tandem	22380 lb
Front axle of trailer tandem	19840 lb
Back axle of trailer tandem	<u>24880 lb</u>
	101420 lb

DOCUMENTATION OF AXLE LOADINGS (OCTOBER 6-7, 1995)

The next truck weighing took place at the Lakeville weigh station on October 6 and 7 of 1995. Both the Mack and the Navistar were weighted in both the heavy and light configurations. Both trucks had full fuel tanks and the driver was in the drivers seat. The axle weights are as follows:

Navistar in the 80 kip configuration, trailer tandem dolly in the white position (see description of the "white position" later in this document) and the tractor fifth wheel in the white position. Nineteen weights were positioned at the front of the trailer and 23 were positioned at the rear of the trailer. This is the configuration that the Navistar has been running since the LVR opened June 15, 1994, with the exception of the weight shift of March 28, 1995.

Steering axle	11540 lb
Front axle of truck tandem	16920 lb



Back axle of truck tandem	16560 lb
Front axle of trailer tandem	16460 lb
Back axle of trailer tandem	<u>17600 lb</u>
TOTAL	79080 lb

The Navistar was weighed in a modified 80 kip configuration, with 43 one-thousand weights, trailer tandem dolly in the white position and the tractor fifth wheel in the yellow position (see the description of "yellow position" later in this document). Twenty weights were positioned at the front of the trailer and 23 weights positioned at the rear of the trailer. The use of this modified configuration was not implemented.

Steering axle	11960 lb
Front axle of truck tandem	17180 lb
Back axle of truck tandem	16840 lb
Front axle of trailer tandem	16300 lb
Back axle of trailer tandem	<u>17840 lb</u>
TOTAL	80120 lb

Navistar in the 102 kip configuration, trailer tandem dolly in the furthest back position and the tractor fifth wheel in the yellow position. Thirty weights were positioned at the front of the trailer and 35 weights were positioned at the rear of the trailer. This is the configuration that has been used since the opening of the LVR June 15, 1994 with the exception of the trailer tandem dolly position which was previously (previous to October 6, 1995) run in the yellow position and the weight shift of March 28, 1995.

Steering axle	12380 lb
Front axle of truck tandem	21440 lb
Back axle of truck tandem	23400 lb
Front axle of trailer tandem	22060 lb
Back axle of trailer tandem	<u>23060 lb</u>
TOTAL	102340 lb

Mack in the standard 80 kip configuration, trailer tandem dolly in the white position and the tractor fifth wheel in the 4th position. The Mack fifth wheel has always been in 4th. Nineteen weights were positioned at the front of the trailer and 23 weights were positioned at the rear of the trailer. This configuration has been used since the opening of the LVR June 15, 1994, with the exception of the weight shift of March 28, 1995.

Steering axle	12000 lb
Front axle of truck tandem	16880 lb
Back axle of truck tandem	16560 lb
Front axle of trailer tandem	15580 lb
Back axle of trailer tandem	<u>18390 lb</u>
TOTAL	79410 lb

Mack in the 102 kip configuration, trailer tandem dolly in the furthest back position and the tractor fifth wheel in the 4th position. The Mack fifth wheel has always been in the 4th position. Thirty weights were positioned at the front of the trailer and 35 weights were positioned at the rear of the trailer. This configuration has been used since the opening of the LVR June 15, 1994, with the exception of the weight shift of March 28, 1995.

Steering axle	12360 lb
Front axle of truck tandem	22900 lb
Back axle of truck tandem	22220 lb
Front axle of trailer tandem	21160 lb



The dimensions from the trailer tandem axle to the back and front individual axles are 22.25' and 25.75" respectively. The back axle load is:

$$33970 \text{ lb} \cdot [25.75 / (22.25 + 22.75)] = 18223 \text{ lb}$$

The axle load for the front axle is:

$$33970 \text{ lb} \cdot [22.25 / (22.25 + 25.75)] = 15746 \text{ lb}$$

Load on the fifth wheel:

$$17120 \text{ lb} + 42000 \text{ lb} - 33970 \text{ lb} = 25150 \text{ lb}$$

Load on truck steering axle:

$$20290 \text{ lb} \cdot [10.23 / (8.25 + 10.23)] + 25150 \text{ lb} \cdot [0.58 / (0.58 + 18.48)] = 11997 \text{ lb}$$

Load on truck tandem:

$$20290 \text{ lb} \cdot [8.25 / (8.25 + 10.23)] + 25150 \text{ lb} \cdot [18.48 / (0.58 + 18.48)] = 33442 \text{ lb}$$

Load on rear axle of truck tandem:

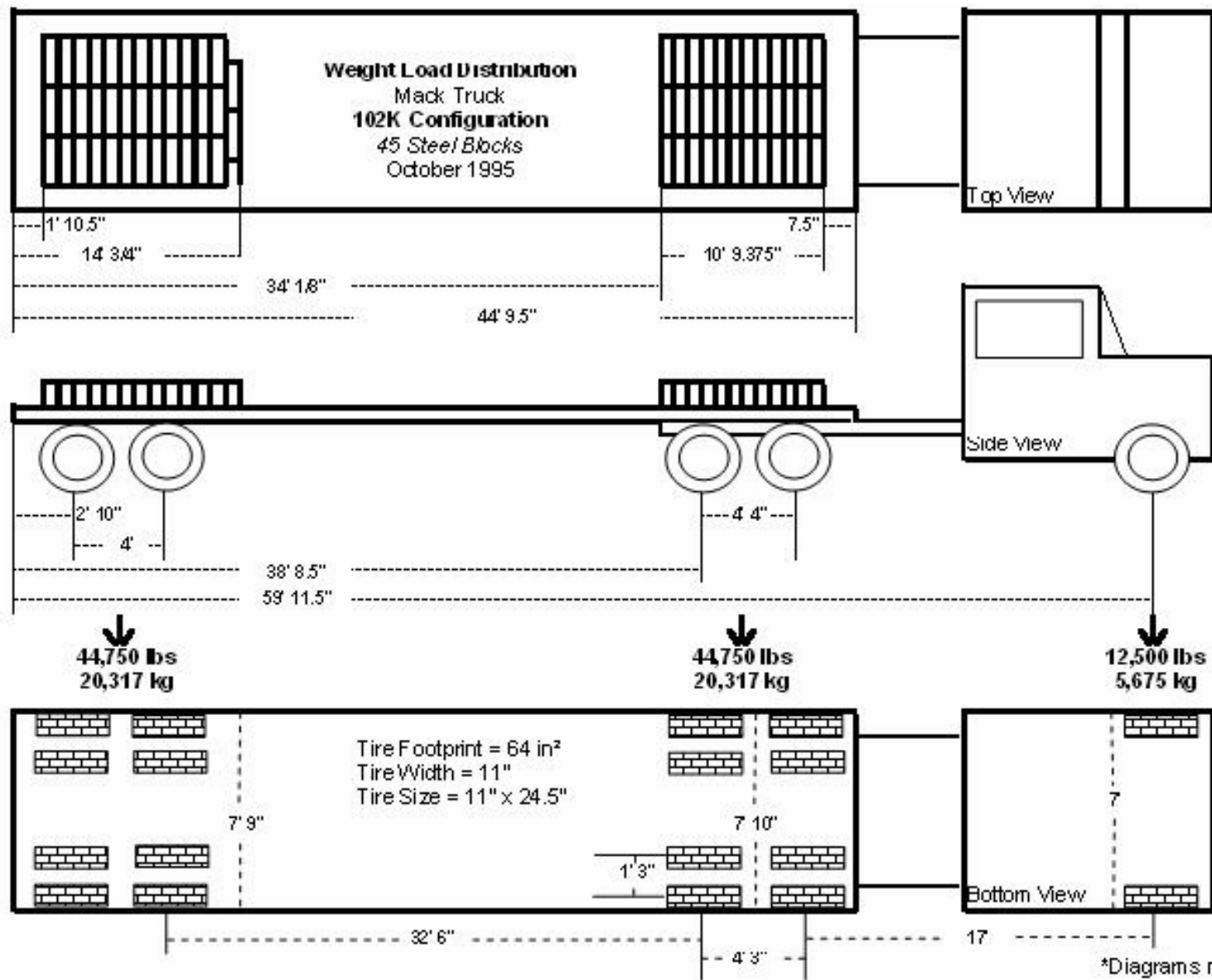
$$3342 \text{ lb} \cdot [2.15 / (2.15 + 2.19)] = 16567 \text{ lb}$$

Load on front axle of truck tandem:

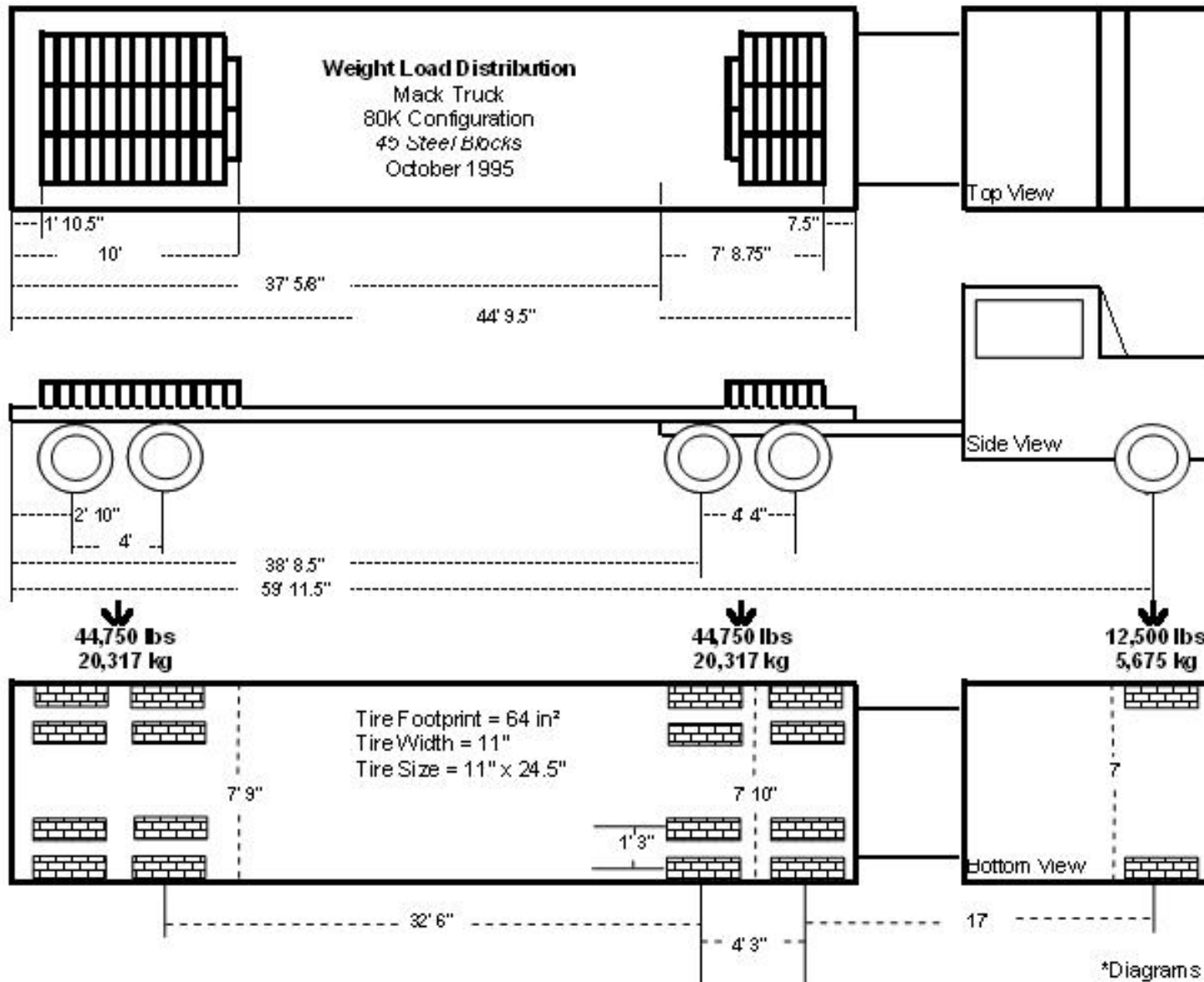
$$33442 \text{ lb} [2.19 / (2.15 + 2.19)] = 16875 \text{ lb}$$



102K CONFIGURATION – MACK:



80K CONFIGURATION – MACK:

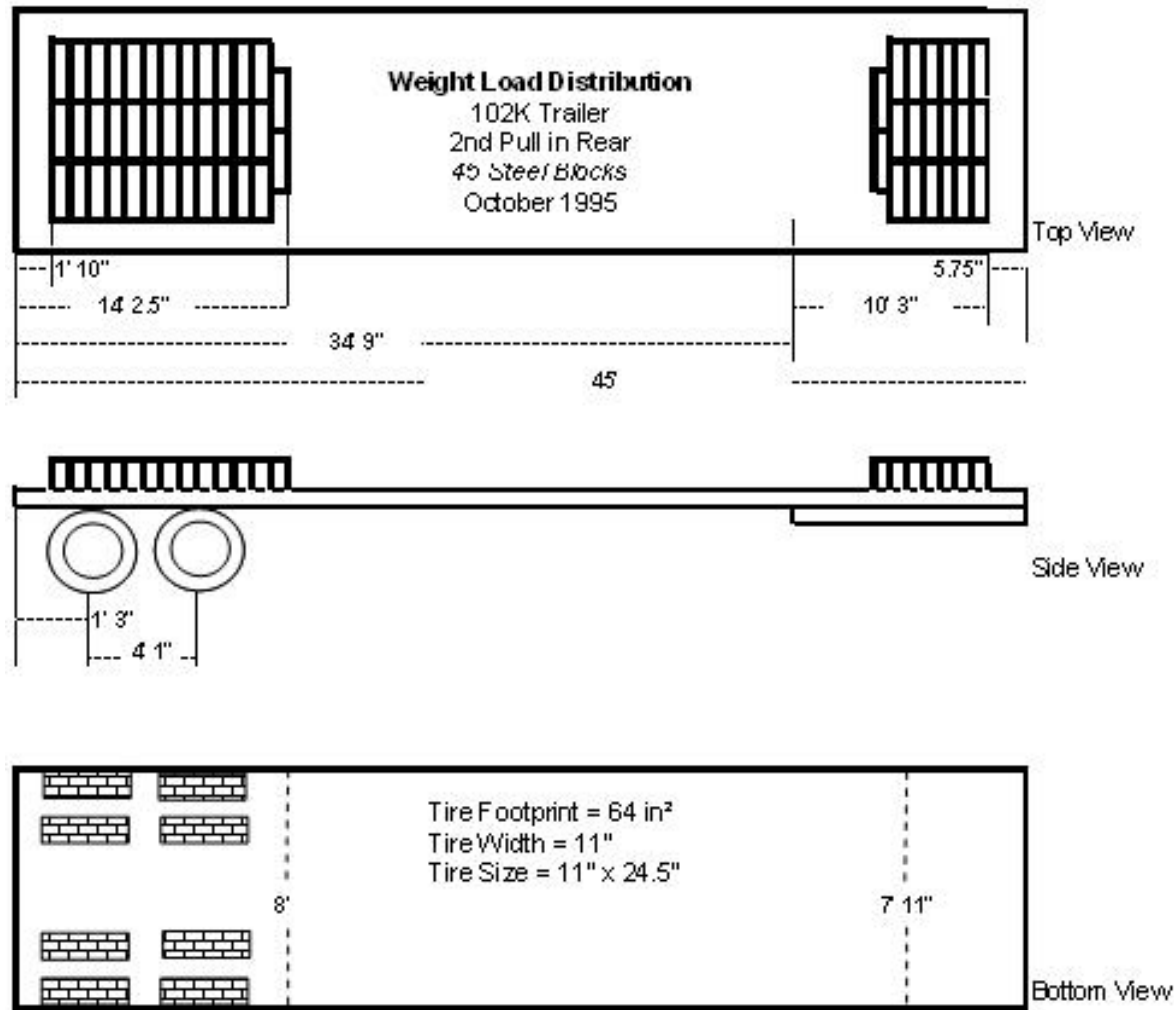


*Diagrams not to scale



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102K TRAILER CONFIGURATION

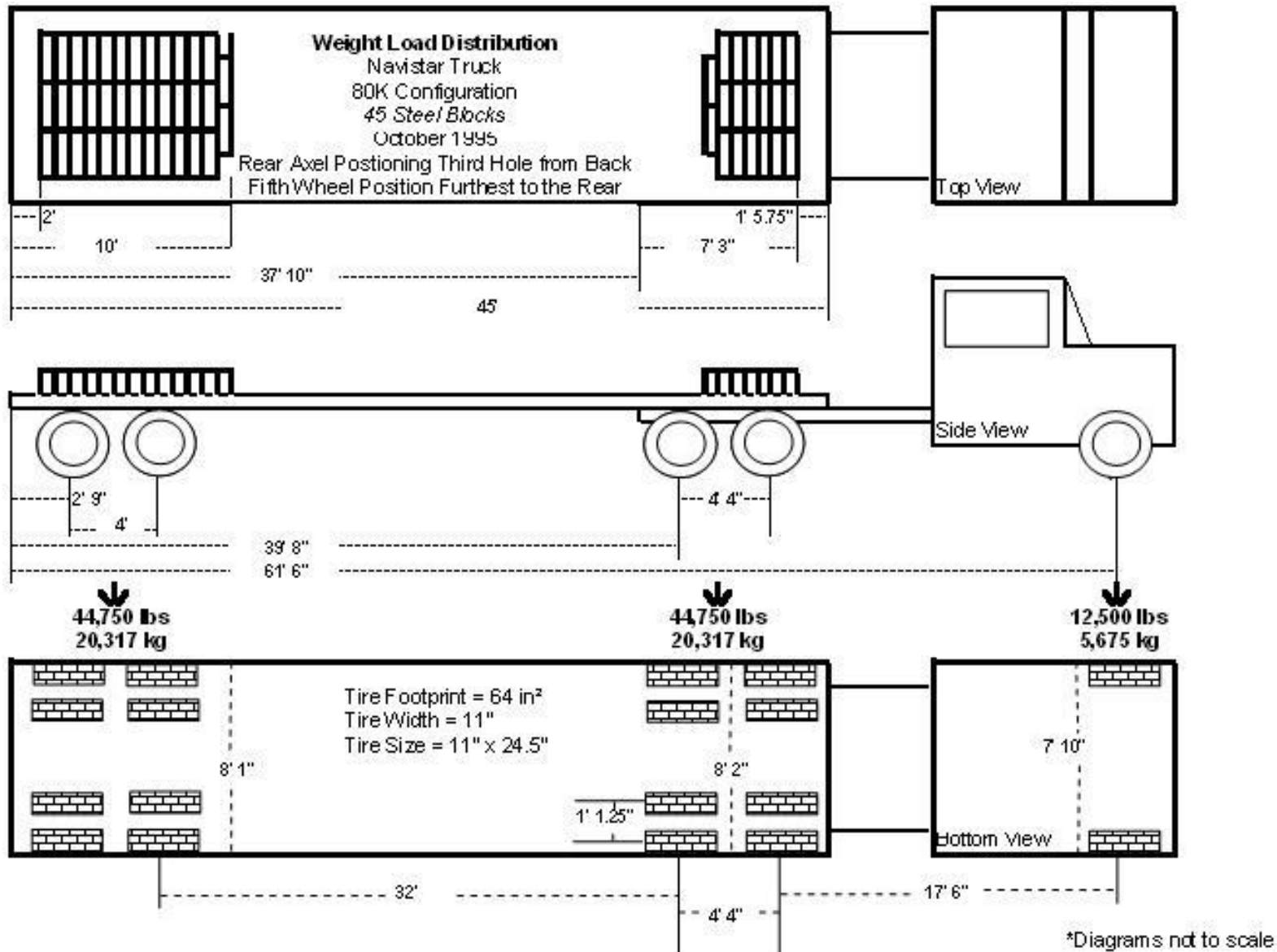


*Diagrams not to scale



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80K CONFIGURATION – NAVISTAR



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For more information:

For more information about MnROAD and the Road Research program at Mn/DOT:

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