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EVALUATION OF PRESENT LEGISLATION AND REGULATIONS ON TIRE SIZES, CONFIGURATIONS AND LOAD LIMITS

EXECUTIVE SUMMARY

by

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for the

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Introduction

In 1979 as a result of the bankruptcy of the Milwaukee Railroad, transportation of lime rock between a quarry near Kendall, Washington and a cement plant near Bellingham shifted to trucks. A major portion of this haul was made on State Route 542. The carrier (Lynden Transportation Co.) was permitted to increase the gross load from present legal load limit of 80,000 pounds to 105,500 pounds as per state permit regulations, Chapter 46.44 (Appendix A). The carrier is permitted to distribute 105,500 pounds over 8 axles or more as long as any single axle did not exceed 20,000 pounds and any tandem axle did not exceed 34,000 pounds and the maximum load on any tire did not exceed 550 pounds per inch width for tires less than 12 inches wide and 660 pounds per inch width for tires 12 inches wide or greater. The tire and axle configuration selected by the carrier is shown in Figure 1. The carrier elected to use tandem axles with single tires rather than single axles with dual tires because this permitted up to 21,680 pounds on four tires.

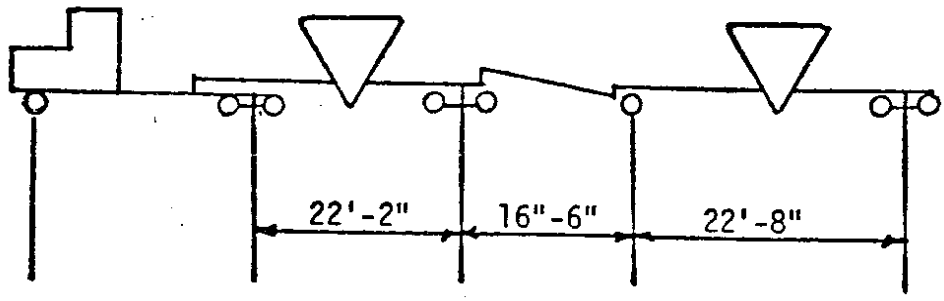
This loading was controlled by the 660 pounds per inch of tire. If the carrier had used single axles with dual tires, the maximum load on four tires would have been 20,000 pounds as controlled by the maximum single axle load regulation. Using dual wheel tandem axles would have reduced the payload that could be hauled by the weight of the 8 additional tires and wheels without providing any advantage to the carrier.

The trucks are making approximately 95 to 105 trips per day. The result of this hauling operation has been to increase the pavement and shoulder maintenance costs for this section of highway from an average of approximately $28,000 per year for the years 1977-1979 to approximately $51,000 per year for the years 1980 to 1981.

Based on the experience of SR 542, WSDOT wanted to know if this occurrence was the beginning of a statewide trend and if so how would the highways sustain the increased loads both from a structural and economic point of view. Hence, this study was initiated to look into several aspects of the present laws and regulations governing truck weights and present recommendations for changes, if any, to minimize damage without seriously affecting the local economy.

The principle regulation evaluated was the Revised Code of Washington (RCW) 46.44.042:

> "Maximum gross weights - tire factor...it is unlawful to operate any vehicle upon the public highways with a gross weight, including load, upon any tire concentrated upon the surface of the highway in excess of 550 lbs per inch width of such tire, up to a



Axle No.	1	2	3	4	5
Tire Size	11.00 x 22.5	11.00 x 22.5	12.00 x 22.5	11.00 x 22.5	12.00 x 22.5
Approx. Axle Load (Kips)	10	27	24	20	24
Configuration TIRE/AXLE (Existing)	SINGLE/SINGLE	DUAL/TANDEM	SINGLE/TANDEM	DUAL/SINGLE	SINGLE/TANDEM

Figure 1. Tire Axle Configuration of the Lime Rock Trucks.

maximum width of 12 inches and for a tire having a width of 12 inches or more there shall be allowed a 20 percent tolerance above 550 lbs per inch width of such tire."

Study Approach

The majority of the pavements in the state can be divided into two categories:

1. Flexible pavement consisting of an asphalt concrete surface layer, gravel base layer and subgrade.

2. Rigid pavement consisting of a portland cement concrete layer, gravel base and subgrade.

As each type of pavement performs differently under the same truck loads and environmental influences, a separate analysis was conducted to study the load carrying capacity of each pavement type.

The study approach is outlined in Figure 2.

The material properties were chosen to represent varying soil types in different parts of the state, climatic changes and other pertinent factors such as a range of layer thicknesses of each type of pavement.

Truck loads were varied to include several axle-tire configurations that are presently being used on the highway network including those that are projected to be used by the American Trucking Industry. Some of the basic assumptions used in this analysis are:

1. That asphalt concrete pavement fails because of repeated applications of heavy truck loads and that the maximum horizontal tensile strain occurs at the bottom of the asphalt concrete layer, and this strain causes cracks to occur in that layer.

2. That asphalt concrete pavement develops ruts in the wheel paths because of repeated application of heavy truck loads and that the magnitude of rut depth is governed by the quality of subgrade soil and the quality of pavement layers above it.

3. That portland cement concrete pavement fails because of repeated application of heavy truck loads which cause pumping, cracking and eventual deterioration of pavement riding quality. Heavy truck loads in conjunction with varying temperature conditions cause tensile stresses at the bottom edge of the concrete slab to exceed the design strength of the concrete resulting in cracked slabs.

Also refer to Appendix B regarding explanation of magnitude of damage to highway pavements attributable to either truck loading

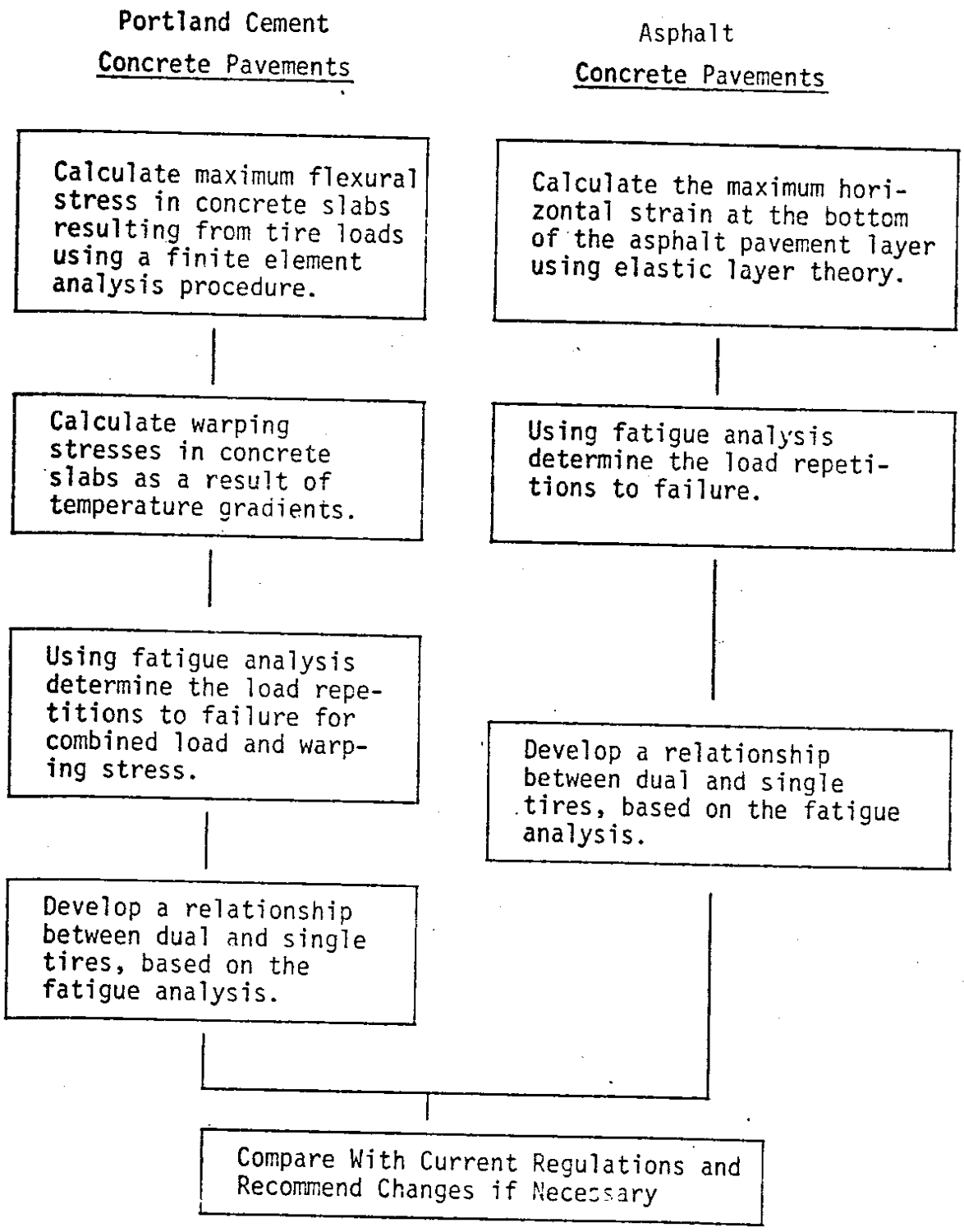


Figure 2. Study Approach

or environment, or a combination of these factors.

Using these failure criteria, comparisons were made between single axles with single tires (tire widths ranged from 10 inches to 18 inches) and conventional single axles with dual tires (tire widths of 10 inches each). For flexible pavement, three pavement sections were considered: 3, 6 and 9.5 inches of asphalt concrete. For rigid pavements, a 9 inch thick portland cement concrete pavement over a subgrade with a low to modest strength (k = 100 pci) was considered. The results of these comparisons are plotted in Figure 3.

This figure illustrates the relationship between loads on a single axle with single tires of different widths that will give the same life as a conventional dual tire, single axle weighing 20,000 pounds.

Example

Q. How does the present tire factor law affect the 3 inch asphalt concrete pavement?

A. From Figure 3, 11,500 pounds on a single axle with single tires 11 inches wide will give the same life for 3 inch asphalt concrete pavement as a conventional single axle weighing 20,000 pounds with dual tires 10 inches wide.

Based on the present law, a single axle with a 11 inch wide tire is allowed to carry up to 12,100 pounds (600 pounds more than allowable by the equivalent pavement life approach).

When using 12 inch tires, which is commonly used on milk trucks and other similar combination vehicles, the contractor can legally carry as much as 15,840 pounds on a single axle. This load is likely to cause more damage to pavements less than 9 inches thick, which happens to be the majority of the pavement mileage in this state.

For tires greater than 12 inches wide, the damage to the pavements by single tires far exceeds that done by the dual tires on a single axle.

Comparison of Tire Size Factor with Other States

It appears that 24 states use tire size factors to control loads and range from 450 to 800 pounds per inch width of tire.

Six states including Washington use 550 pounds per inch width or less, the rest allow greater tolerances.

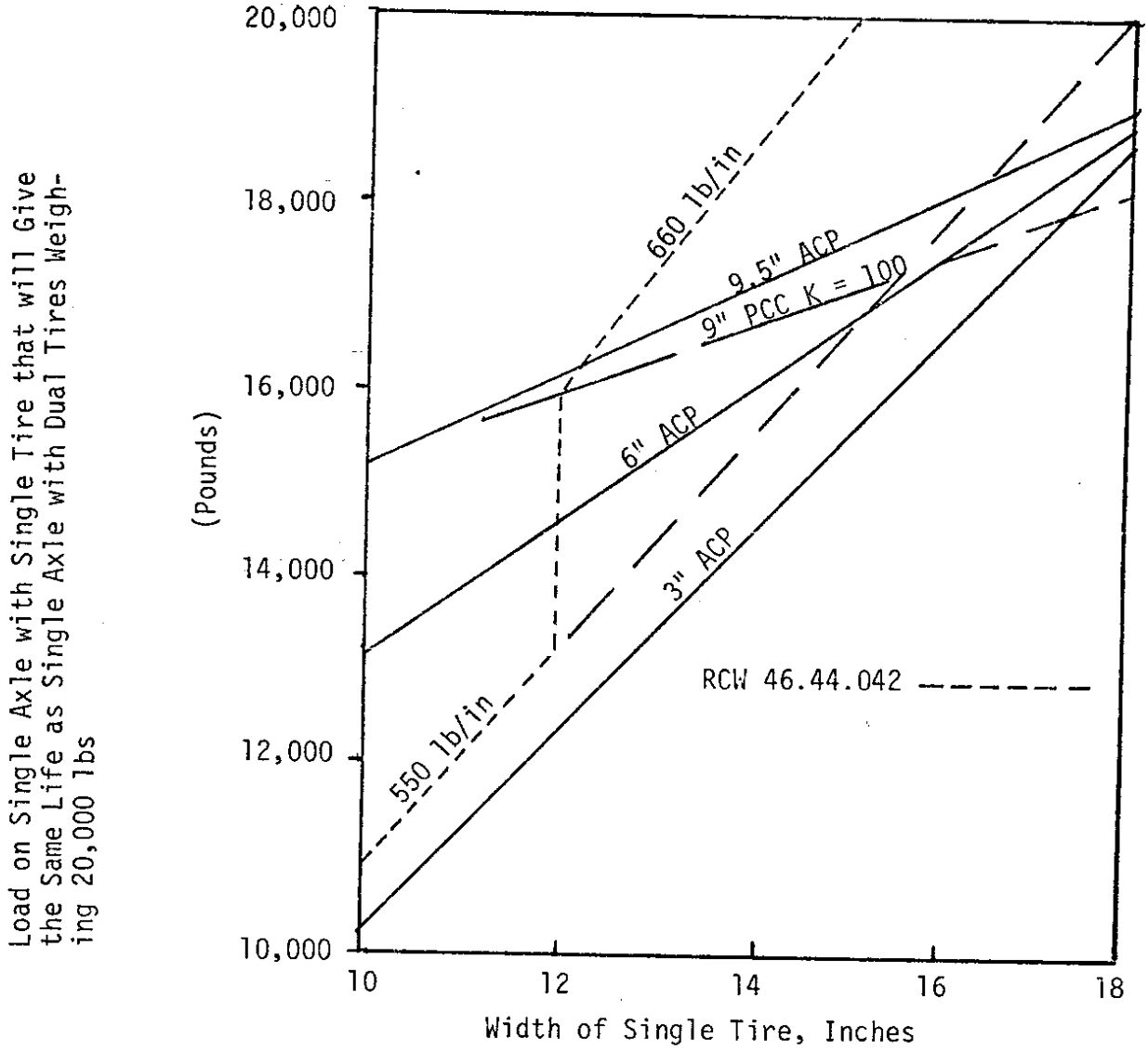


Figure 3. Comparison of the Regulation Requirements for Maximum Tire Loads with the Dual and Single Tire Relationships for Equivalent Fatigue Life. Dual Tire Axle Load Equals 20,000 lb with 10 Inch Wide Tires.

Table 1 summarizes the tire size factors for various states.

Conclusions

1. The pavement section on SR 542 was substantially less than required for the truck traffic it was required to carry. Thus, it is doubtful if any axle configuration would have resulted in a reduction of the maintenance effort required on this section.

2. Lynden Transportation Co. legally arranged their tire and axle configuration as shown in Figure 1 to maximize their haul, but the configuration used was found to do the most pavement damage.

3. A truck survey was conducted to see if the use of single tires is an increasing trend. The survey showed that 9 percent of the trucks exceeded the legal load limit and about 6 percent used single tires on the rear axle and all violated RCW 46.44.042. There were several cases where on dual tired axles, either the tire pressure on the inside tire was very low compared to the outside adjacent tire, or the tire was blown out. In these cases, the analysis shows that there was violation of RCW 46.44.042. Refer to Appendix C for the types of trucks surveyed.

Recommendations

1. It is tentatively advised that the 20 percent tolerance for maximum gross loads on tires 12 inches wide or greater should be deleted from RCW 46.44.042.

2. Washington State RCW 46.44.095 should be revised to require that proposed tire and axle configurations be submitted with the permit application for review and approval prior to receiving an extra tonnage permit. A comparison of the cost of pavement damage versus cost to the carrier should serve as a basis for determining a satisfactory tire-axle configuration. However, in no case should the maximum axle loads for 20,000 pounds for a single axle and 34,000 pounds for a tandem axle or maximum tire load of 550 pounds per inch be exceeded.

Table 1. Comparison of Tire Width Regulations for Various States

States	Tire Size Factor (lb/in)
Alaska	500
Connecticut	600
Florida	550
Idaho	800
Indiana	800
Kentucky	600
Louisiana	450
Maine	600
Massachusetts	800
Michigan	700
New Hampshire	600
New Jersey	800
New Mexico	600
New York	800
North Carolina	600
North Dakota	550
Ohio	650
Oregon	550
Pennsylvania	800
South Dakota	600
Texas	650
Vermont	600
Virginia	650
Washington	550

APPENDIX A

Washington State Patrol Size,
Weight, and Load-Chapter 46.44

Washington State Patrol
SIZE, WEIGHT, AND LOAD--CHAPTER 46.44

Outside Width (46.44.010)
Eight Feet (96 inches) inclusive of load for all vehicles

Tolerances:

1. Rear View Mirror - five (5) inches
2. Rubber fenders - two (2) inches
3. Tires (due to expansion) - two (2) inches
4. Safety appliances (clearance lights, rub rails, binder chains) - two (2) inches
5. Appurtenances (door handles, door hinges, and turning signal brackets) - two (2) inches

Maximum Height (46.44.020)
Fourteen (14) feet

Except:

1. Authorized emergency vehicle or repair equipment of a public utility engaged in reasonably necessary operations

Maximum Length (46.44.030)
Single vehicle - forty (40) feet with or without load

Except:

1. The permanent structure of a single vehicle in combination not to exceed forty-five (45) feet; forty-seven (47) feet with monthly, quarterly, or annual special motor vehicle permit.

   Exception: Refrigeration units placed on the front of van trailers

Combination of vehicles:

1. The overall length of any combination consisting of a *nonstinger steered tractor and semitrailer shall not exceed sixty-five (65) feet. A *stinger steered tractor and semitrailer shall not exceed sixty-five (65) feet without load and seventy (70) feet with load.

2. The overall length of combination of vehicles consisting of a truck and trailer or any lawful combination of three vehicles shall not exceed sixty-five (65) feet with or without load; seventy-five (75) feet with monthly, quarterly, or annual special motor vehicle permit.

*Stinger steered shall mean a tractor and semitrailer combination, which has the coupling connecting the semi-trailer to the tractor located to the rear of the center line of the rear axle of the tractor.

WSP-WC-107 7/80

3. These length limitations shall not apply to vehicles transporting poles, pipes, machinery, or other objects of a structural nature that cannot be dismembered, and operated by a public utility when required for emergency repairs of public service facilities or properties.

Maximum Length of Protrusions (46.44.034)

1. Front - Three (3) feet
2. Rear - Fifteen (15) feet beyond last axle

Combination Limits - Two vehicles (46.44.036)

1. Exceptions: (46.44.037)

   a. Truck tractor, semitrailer, and trailer in combination.

   b. Truck tractor, semitrailer, and semitrailer in combination (B train)

      (1) The converter gear (dolly) may be pulled behind a tractor and semitrailer in lieu of a full trailer.

   c. Three trucks or three truck tractors in double saddle-mount position.

Gross Weights - Tire

1. 550 pounds per inch width (46.44.042)

   a. Tire having a width of twelve inches or more shall be allowed a twenty percent tolerance above 550 pounds per inch. (Tire size chart on Page 7 of this pamphlet.)

Excess Weight - logging trucks operating on a permit (46.44.047)

1. Only the three-axle tractor and two-axle pole trailer are allowed to have the permit and are valid only on State primary and secondary highways authorized by the State Department of Transportation.

   a. A map is issued showing the approved routes.

2. An additional six feet of wheelbase is given if the combination is thirty-seven feet or more between the first and last axles.

3. 1,600 pounds tolerance on dual axles.

4. 6,800 pounds tolerance on the combination.

5. Permit may be transferred ($5 fee).

6. Cities and counties may issue a "County Log Tolerance" permit for county roads.

   a. May charge a $5 fee.

   b. Shall designate the routes to be used.

c. Issued on a yearly basis, expiring March 31 of each year.

d. Any person, firm, or corporation using any city street or county road for the purpose of transporting logs with weights authorized by the State highway log tolerance permits, to reach a State highway route, without first obtaining a city or county log tolerance permit when required by the city or county shall be subject to the excess weight penalties.

Special Permits for Oversize or Overweight Vehicles (46.44.090)

1. Issued by Department of Transportation for State highways--by local authorities with respect to the public highways under their jurisdiction.

Gross Weight Limits of Special Permits (46.44.091)

1. 22,000 pounds on a single axle.

2. 43,000 pounds on any group of axles more than 3 feet 6 inches apart and less than 7 feet apart.

3. Weight limits may be exceeded on highways designated for greater weight.

4. Construction equipment may exceed the above with large pneumatic tires.

Special Permit Width Limits (46.44.092)

1. 14 feet on a two-lane highway

2. 32 feet on a multiple-lane highway: Except multiple-lane highways with physical barrier serving as a median divider not in excess of 20 feet.

3. Exceptions:

   a. May be exceeded on highways designed and constructed for greater widths.

   b. May be rescinded during an emergency.

   c. 16 feet on a two-lane highway during daylight hours when the weight does not exceed 45,000 pounds.

   d. Buildings in excess of 14 feet may be moved not to exceed five miles.

Oversize Permits - Fees (46.44.0941)

1. Annual permit for 75 feet in length - $60.

   a. Permits are not restricted to hours or days.

Gross Weights (46.44.041)

1. Single axle - 20,000 pounds

2. Single drive axle garbage trucks - 22,000 pounds with additional tonnage permit

   a. Not valid on interstate system

3. Tandem axles - 34,000 pounds

   a. Axles spaced less than 7 feet must oscillate

4. Three-axle vehicle - 40,000 pounds

   a. Weight in excess of 40,000 pounds, allowed by additional tonnage permit, determined by tire size and wheelbase table.

5. Vehicle combinations - 80,000 pounds

   a. Weight in excess of 80,000 pounds, allowed by additional tonnage permit, determined by tire size and wheelbase table, using overall and internal spacing.

Wheelbase Table (46.44.041)

1. Overall measurement is from the center of the front axle on a vehicle or combination of vehicles to the center of the last axle on vehicles or combinations of vehicles.

2. Internal measurement will include groups of axles, and groups of two consecutive sets of tandem axles.

   a. Tandem axles will not be split when measuring internal spacing.

3. Minimum wheelbase - three feet, six inches, except axles spaced less than three feet, six inches may not exceed the maximum weight allowed for a single axle (46.44.050).

4. When inches are involved in wheelbase measurements, under six (6) take lower, six (6) inches or over, take the higher weight.

5. Steering axle weights are determined by tire size (46.44.042).

6. <u>No enforcement tolerance will be allowed</u>.

7. To determine license gross weight and additional tonnage weight, follow the examples of overall and internal measurements. Apply the total number of axles in the overall or internal measurement and apply this to the appropriate columns on the table for gross weights.

8. Establishes a grandfather provision for vehicle or combination of vehicles in operation on January 4, 1975, to operate with weights on two consecutive sets of dual axles in effect by law on that date. This provision will allow 32,000 pounds on a tandem axle and a combined gross weight of 73,280 pounds for certain combinations.

Combinations operating under the grandfather provision will be required to purchase a license gross weight tonnage of 74,000 pounds. A five axle combination with a minimum overall wheelbase measurement of 44' 6" would be allowed 73,280 pounds. Combinations with less than 44' 6" wheelbase, their weights will be determined by the enclosed vehicle loading chart. As in the past, we will not measure internal wheelbase on vehicles operating within the weights allowed by the grandfather provision. No tolerance will be allowed over these weights.

Additional Tonnage Permits (46.44.095)

1. Issued by the Department of Transportation.

2. Permits are issued annually with fees reduced by 1/12 or monthly instead of quarterly ($37.50 per thousand pounds).

   a. Permits may be transferred - fee $5.

   b. Seasonal vehicles may purchase permits quarterly. Must purchase a minimum of 6,000 pounds.

3. Temporary additional tonnage permits may be purchased for a minimum of five days at $1 per day for each 2,000 pounds.

4. Violated permits to be sent to the Department of Transportation upon third conviction.

Additional Tonnage Permits - Cities and Counties (46.44.0941)

1. Cities and counties may issue permits for operation on roads or streets under their jurisdiction.

2. Allowed on state roads by endorsement.

Mandatory Fines for Overloading (New Section--Chapter 46.44)

1. Penalties apply to tires (46.44.042), log tolerance permits (46.44.047), special motor vehicle permits (46.44.090 and 46.44.091), additional tonnage permits, axles, wheelbase, vehicles and combinations of vehicles (46.44.095), failure to obtain, display, or misrepresentation of permits (46.44.090 and 46.44.095).

2. Violation is a misdemeanor and is punishable as follows:

   a. Basic fine:

      (1) First violation - not less than $50.

      (2) Second violation - not less than $75. In addition, the court may suspend the license registration.

      (3) Third violation - not less than $100. In addition, the court shall suspend the license registration.

      (4) For license registration suspension purposes, first, second, and third violations are within any twelve-month period.

(5) In no case may the basic fine be suspended.

b. Poundage penalty (in addition to basic fine)

(1) Three cents per pound, provided that upon the first violation within a calendar year, the court may suspend 500 pounds on each axle, up to a maximum of 2,000 pounds on any combination of vehicles.

c. For license suspension purposes, bail forfeitures are given the same effect as convictions.

d. Convictions are figured on a calendar year and must be on the same vehicle or combination of vehicles.

e. Penalties for violation of a posted limitation (winter restrictions)

(1) First violation - not less than $150

(2) Second and subsequent violations - not less than $150 and, in addition, the court shall suspend the license registration for not less than 30 days.

f. Vehicles or combinations of vehicles of which the owner or operator represent as being disabled or otherwise unable to submit to immediate weighing will be sealed or marked. Removal of the seals, markings, or any part of the load prior to weighing will be punishable by a fine of not less than $500 and suspension of the license registration for not less than 30 days.

Weighing and Lightening

1. May require the operator to stop and submit to being weighed by portable scales or directed to the nearest public scales.

2. May require the load to be reduced to legal limits.

Liability for Overloading (46.44.120)

1. Owner, operator, and any person knowingly and intentionally participating in creating any unlawful condition of use shall also be subject to the penalties provided in this chapter.

Overloading Licensed Capacity - Additional License (46.16.140)

1. It is a misdemeanor to operate a vehicle in excess of the licensed gross weight.

a. Any person who operates a vehicle with a gross weight in excess of the licensed gross weight shall be deemed to have established a new gross weight and in addition to any other penalties shall be required to purchase a new tonnage license covering the new maximum gross weight.

(1) Failure to secure such new license shall be a misdemeanor.

(2) No such person shall be permitted or required to purchase additional gross weight which would exceed the gross weight allowed by law--increasing beyond the legal limits of tires or axles or vehicles.

Overloading Licensed Capacity--Penalties (46.16.145)

1. Establishes statutory fines and penalties for operating vehicles in excess of the licensed gross weight.

   a. First conviction $25 to $50 fine.

   b. Second conviction $50 to $100 fine and the court may suspend the registration.

   c. Third conviction $100 to $200 fine and the court shall suspend the registration for not less than thirty days.

Movement of Farm Implements (46.44.130)

Farm implements of less than 45,000 pounds gross weight and a total outside width of less than 20 feet may move over State highways while patrolled, flagged, lighted, signed, and at a time of day in accordance to rules to be adopted by the Department of Transportation under terms of a special permit to be issued by the Department of Transportation for a quarterly or annual period.

TIRE SIZE TABLE

Subject to the maximum gross weight for axle, axles, and vehicles.

Tire Size	Single Tire	2 Tires (1 Axle)	4 Tires (1 Axle)	8 Tires (2-Axle Duals)	10 Tires (3-Axle Veh.)
8:25	4537.5	9075	18150	36300	45375
9:00	4950	9900	19800	39600	49500
10:00	5500	11000	22000	44000	55000
11:00	6050	12100	24200	48400	60500
12:00	7920	15840	31680	63360	79200
18:00	11880	23760	47520	(Flotation Type - Used Singly on Drive Axles)	

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

VEHICLE WEIGHT TABLE

Drawn in accordance with Chapter 189, Session Laws of 1937
as last amended by Chapter 46.44 Session Laws of 1977
MARCH 1977

No vehicle or combination of vehicles shall operate upon the public highways of this state with a gross load on any single axle in excess of twenty thousand pounds, or upon any group of axles in excess of that set forth in the following table, except that two consecutive sets of tandem axles may carry a gross load of thirty-four thousand pounds each, if the overall distance between the first and last axles of such consecutive sets of tandem axles is thirty- six ft. or more.

Distance in feet between the extremes of any group of 2 or more consecutive axles	Maximum load in pounds carried on any group of 2 or more consecutive axles								
	2 axles	3 axles	4 axles	(Maximum load in lbs. carried on any group of 2 consecutive sets of tandem axles)	5 axles	6 axles	7 axles	8 axles	9 axles
4	34,000								
5	34,000								
6	34,000								
7	34,000								
8	34,000	36,500							
9	39,000	38,000							
10	40,000	39,500							
11		S 41,000							
12		E 42,500	42,500						
13		E 44,000	44,000						
14		45,500	45,500						
15		N 47,000	47,000						
16		O 48,000	48,000		48,000				
17		T 48,500	48,500		49,000				
18		E 49,500	49,500		50,000				
19		50,000	50,000		51,000				
20		B 51,000	51,000	(55,500)	52,000	52,000			
21		E 51,500	52,500	(56,000)	53,000	53,000			
22		L 52,500	52,500	(56,500)	54,000	54,000			
23		O 53,000	53,000	(57,500)	55,000	55,000			
24		W 54,000	54,000	(58,000)	55,500	56,000	56,000		
25		54,500	55,000	(58,500)	56,500	57,000	57,000		
26		55,500	56,000	(59,500)	57,500	58,000	58,000		
27		56,000	57,000	(60,000)	58,500	59,000	59,000		
28		57,000	58,000	(60,500)	60,000	60,000	60,000	60,000	
29		57,500	59,000	(61,500)	60,500	61,000	61,000	61,000	
30		58,500	59,000	(62,000)	61,500	62,000	62,000	62,000	
31		59,000	60,500	(62,500)	62,500	63,000	63,000	63,000	
32		60,000	61,500	(63,500)	63,500	64,000	64,000	64,000	64,000
33			62,500	(64,000)	64,500	65,000	65,000	65,000	65,000
34			63,500	(64,500)	65,000	66,500	66,500	66,500	66,500
35			64,500	(65,500)	66,500	67,500	67,500	67,500	67,500
36			65,500	(68,000)	67,500	68,500	68,500	68,500	68,500
37			66,500		68,500	69,500	69,500	69,500	69,500
38			67,500		69,000	70,500	70,500	70,500	70,500
39			68,000		70,000	71,500	71,500	71,500	71,500
40			68,500		71,000	72,500	72,500	72,500	72,500
41			69,500		72,000	73,500	73,500	73,500	73,500
42			70,000		73,000	74,500	74,500	74,500	74,500
43			70,500		74,000	75,500	75,500	75,500	75,500
44			71,500		75,000	76,500	76,500	76,500	76,500
45			72,000		76,000	78,000	78,000	78,000	78,000
46			72,500		76,500	79,000	79,000	79,000	79,000
47			73,500		77,500	80,000	80,000	80,000	80,000
48			74,000		78,000	81,000	81,000	81,000	81,000
49			74,500		78,500	82,000	82,000	82,000	82,000
50			75,500		79,000	83,000	83,000	83,000	83,000
51			76,000		80,000	84,000	84,000	84,000	84,000
52			76,500		80,500	85,000	85,000	85,000	85,000
53			77,500		81,000	86,000	86,000	87,000	87,000
54			78,000		81,500	86,500	87,500	89,000	89,000
55			78,500		82,500	87,000	88,000	91,000	91,000
56			79,500		83,000	87,500	90,000	93,000	93,000
57			80,000		83,500	88,000	91,000	95,000	95,000
58					84,000	89,000	92,500	97,000	97,000
59					85,000	89,500	93,500	99,000	99,000
60					85,500	90,000	95,000	100,500	100,500
61					86,000	90,500	96,500	101,000	102,500
62					86,500	91,000	96,000	101,500	104,000
63					87,500	92,000	96,500	102,000	105,000
64					88,000	92,500	97,000	102,500	105,500
65					88,500	93,000	98,000	103,000	105,500
66					89,000	93,500	98,500	103,500	105,500
67					90,000	94,000	99,000	104,000	105,500
68					90,500	94,500	99,500	104,500	105,500
69					91,000	95,000	100,000	105,500	105,500
70					91,500	96,000	101,000	105,500	105,500

NOTE: It is unlawful to operate upon the public highways any single unit vehicle supported upon 3-axles or more with a gross weight including load in excess of 40,000 lbs. or any combination of vehicles having a gross weight in excess of 80,000 lbs. without first obtaining an additional tonnage permit as provided for in RCW 46.44.095. PROVIDED: That when a combination of vehicles has purchased license tonnage in excess of 72,000 lbs. as provided by RCW 46.16.070, such excess license tonnage may be applied to the power unit subject to limitations of RCW 46.44.042 and this table when such vehicle is operated without a trailer.

The Gross Weight of vehicle and load shall not exceed 550 lbs. per inch width of tire. (660 lbs. 12:00 or larger)

The Overall Width of vehicle and load shall not exceed 8 feet.

The Overall Height of vehicle and load shall not exceed 14 feet.

The Overall Length of any single vehicle shall not exceed 40 feet with or without load. The overall length of any combination of vehicle, with or without load, shall not exceed 65 feet. Semi trailers shall not exceed 45 feet.

(Combination of vehicles allowed 75 feet which may contain a 47 foot semi trailer by special permit—RCW 46.44.0941.)

WHEN INCHES ARE INVOLVED: Under six inches take lower. Six inches or over take higher.

The maximum load on any axle in any group of axles shall not exceed 1.2 times the load given in the above table divided by the number of axles in that group, and shall not exceed the single axle or tandem axle allowance as set forth elsewhere. For considering the number of axles in a group the front axle of a unit supplying motive power need not be included in the axle group.

The maximum axle and gross weights specified in this table are subject to the braking requirements set up for the service brakes upon any motor vehicles as provided by law.

It is unlawful to operate any vehicle upon the public highways equipped with two axles spaced less than seven feet apart, unless the two axles are so constructed and mounted in such a manner as to provide oscillation between the two axles and that either one of the two axles will not at any one time carry more than the maximum gross weight allowed for one axle specified in this table.

APPENDIX B

Originally Prepared by WSDOT Materials Lab

A Review of Two Reports Prepared for the American Trucking Association

"Causes of Pavement Damage on Interstate Highways"
by Counsel Trans, Inc.

"Effects of Truck Weights on Pavement Deterioration"
by Texas Transportation Institute

The major emphasis on both of these reports was to estimate the proportion of damage to our highway pavements attributable to either truck loading or environment, or a combination of these factors. In general, both reports conclude that all states experience less distress attributable directly to load than to other causes. Our experience in the State of Washington does not support these findings. The following are our concerns with the data presented in both reports.

"Causes of Pavement Damage on Interstate Highways"

The Counsel Trans report is based on an inventory conducted in six states on selected interstate pavements at least eight years old. The defects rated in the inventory were those normally used, or at least accepted, by most states. A determination was then made as to whether the distress was "...primarily caused by loading..." or "...primarily caused by factors other than loading..." There was no consideration for the effect that load may ultimately have on defects initially caused by environmental factors.

Many of our pavements experience non-load-related defects early in their service life, such as reflective cracking or thermal cracking. These defects are usually of minor severity and have negligible effect on the serviceability of the roadway. In time, the accumulated effect of load causes the severity of these defects to increase to the extent that serviceability is affected. We believe greater consideration should have been given in the report to the effect of load on environmentally induced defects.

Most of our asphalt concrete pavements last 10 to 12 years before they require some form of rehabilitation. In their report, Counsel Trans inventoried select interstate pavements eight years of age or older. It would seem that an inventory collected on pavements in this part of their life cycle, as Counsel Trans has done, would tend to be biased toward non-load-related distresses. It would be more pertinent to conduct an inventory on only those projects which have been identified as requiring rehabilitation or resurfacing in the very near future. An inventory of these sections would indicate what defects are actually present when we make the final decision as to which projects we should spend our all-too-limited funds on.

A review of the inventory data for all of our interstate AC pavement sections requiring rehabilitation or resurfacing in the next biennium indicates that we do in fact experience a much higher proportion of load-related distress than that indicated by Counsel Trans. The following is a rough comparison of our interstate ACP sections which require action to the Counsel Trans study. Some of the defect categories used in the report were combined to fit our defect categories.

	Counsel Trans Distress Summary	WSDOT Distress Summary
Rutting or Wear	53.1%	71%
Alligator Cracking	32.3%	64%
Ravelling or Flushing	22.0% (Ravelling only)	96%
Longitudinal Cracking	91.6%	93%
Transverse Cracking	60.8%	88%
Patching	39.4% (excluding wheel path)	12%

The Counsel Trans findings, as stated in their report, are:

> "Pavement damage reasonably ascribable to vehicular loading, on The National System of Interstate and Defense Highways, is between 35 and 41 percent of the damage attributable to all causes."

Considering data from our own inventory as well as our personal experience, we cannot support these findings. They vastly overstate the effect of non-load-related distress, while under-estimating the effect of load-related distress on pavements requiring rehabilitation.

"Effects of Truck Weights on Pavement Deterioration"

The second report, prepared by the Texas Transportation Institute, also studies the damage which occurs to pavement due to various causes. In their report they have classified the causes into three categories: traffic loads, climate, and a combination of the two. Though they do consider a combined category, they also do not acknowledge the effect load has on increasing the severity of climatically induced defects. There are several defect classifications included in the report which we find questionable. Specifically, we do not consider either non-reflective longitudinal cracking or ravelling as climatically caused distresses. Longitudinal cracking often occurs in the wheel path before alligator cracking. We consider both cracking types load-related. Our experience also indicates ravelling is more dependent upon quality of construction and heavy traffic load than on climate.

To analyze the amount of damage attributable to each cause, TTI used an inventory of metropolitan highways in Minnesota, as well as performance curves for flexible pavements developed in Texas, for composite pavements developed in Minnesota and rigid pavements developed in Illinois. Relative damage functions developed in several different states were then applied to determine perceived effect of the different distresses.

We do not think it prudent to apply damage functions developed in one state to another which may have totally different design and construction requirements. The use of damage equations developed in Washington to analyze pavement performance from Illinois, as was done in the report, is a good example. The rigid pavement equation developed for Illinois is based predominantly on pavements which are reinforced--jointed at 70-ft spacing with dowels used for load support across each joint. In the State of Washington, damage equations were developed based on our own PCC pavements which are almost all unreinforced with joint spacing of 15 ft or less with no load transfer devices. One should expect a significant difference in the occurrence of the various distress categories between unique pavement designs. The difference in experience must

also extend to distress categories. In their report, TTI interpreted one of our distress categories as D-cracking to (we assume) better fit their experience. This was a total misapplication of our weightings as we do not even experience D-cracking. This distress is associated with certain types of rock seldom found in this state and never used as aggregate in our pavements. It would seem reasonable that similar discrepancies between states can apply to the other pavement types. We doubt that specific damage functions can be developed that will accurately represent the performance of either rigid or flexible pavements in all states.

The pavement inventory used in the TTI report was from Minnesota. It was based on selected sections from two districts which apparently control most metropolitan highway routes within the state. One would expect the condition of these pavements to be quite dependent upon the general policies of the State Highway Department. The policies of the State of Minnesota as stated in the report are as follows:

> "The departments felt that the rate of crack deterioration into multiple cracking was dependent on the quality of the subgrade soils, the traffic loading, and environmental conditions. They stated that multiple cracking usually deteriorates to alligatoring if left untreated. Therefore the departments would prefer to usually overlay once multiple cracking has occurred rather than risk a greater expenditure at a later date."

One would also not expect to find much load-associated cracking in an area where the stated policy was to resurface the pavement in anticipation of the onset of this type of cracking. The data from Minnesota are not too surprising then when it shows very little load-associated cracking on average.

Again, our experience in the State of Washington indicates a much higher proportion of load-associated cracking on projects selected for rehabilitation than that indicated in the TTI report. The following direct comparison can be made between those projects identified for rehabilitation in our state and a sample of 20 flexible pavement sections inventoried just prior to maintenance in the TTI report:

	TTI Summary 20 Flexible Pavements from Minnesota	WSDOT Summary Interstate Flexible Pavements Requiring Rehabilitation
Transverse Cracking	87.95%	88%
Longitudinal Cracking	16.48%	93%
Multiple Cracking	11.92%	--*
Alligator Cracking	1.61%	64%
Rutting	3.97%	71%**
Patching	11.29%	12%

*In Washington, multiple cracking is coded as transverse and longitudinal cracking.
**This value also includes flushing.

As can be seen, we experience a much greater amount of longitudinal and alligator cracking which we consider to be load-associated.

In their conclusions, authors of the TTI report make the following observations relative to all states:

> "As shown in this report, the damage that results in a decision to maintain or rehabilitate a pavement is not ascribable to load alone but in some cases is entirely dependent upon climatic influences and in other cases is the result of the combined effect of these two..."

> "...It is also apparent that at the present time there is no consensus among the states about what types of distress should be considered or how heavily each should be weighted in determining a decision criterion for maintenance and rehabilitation activities. But despite the lack of consensus, it is evident that in the estimation of all of the states, climatically caused distress figures heavily in their decision-making in developing a pavement maintenance and rehabilitation program for the state highway networks."

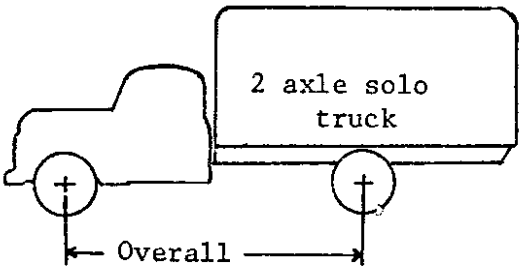
As stated before, considering data from our own inventory as well as our personal experience, we do not agree with these findings. They overstate the effect of non-load-related distress while underestimating the effect of load on pavements requiring rehabilitation. With regard to this report, we specifically feel that more consideration should have been given to the differences between performance models in all states, commensurate with the variation in design and construction practices.

APPENDIX C

Examples of Overall and Internal Measurements to Determine Gross Weight

EXAMPLES OF OVERALL AND INTERNAL MEASUREMENTS TO DETERMINE GROSS WEIGHTS

1.



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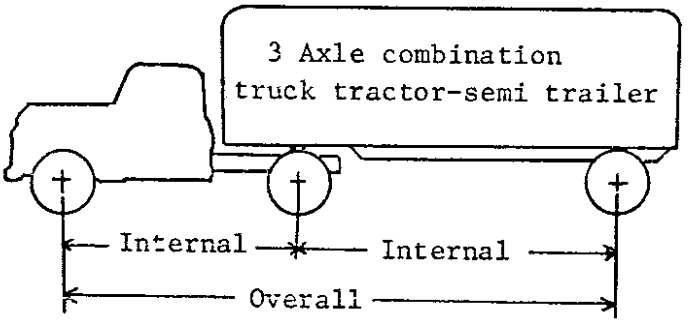

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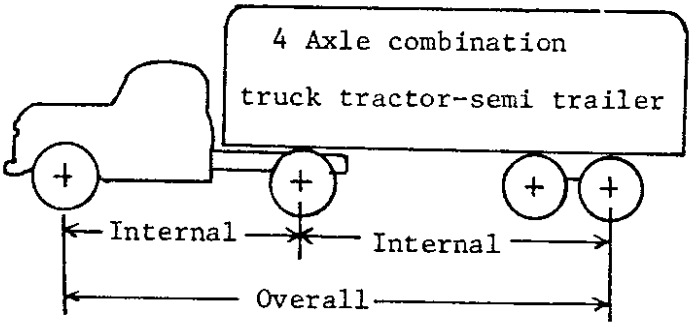

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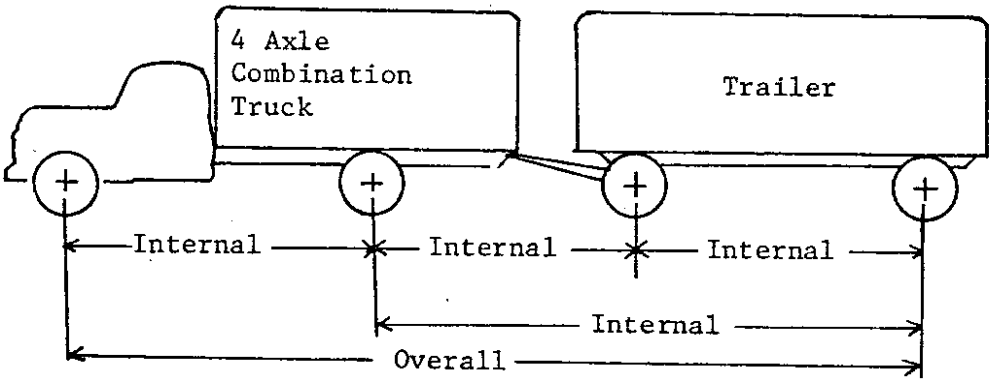

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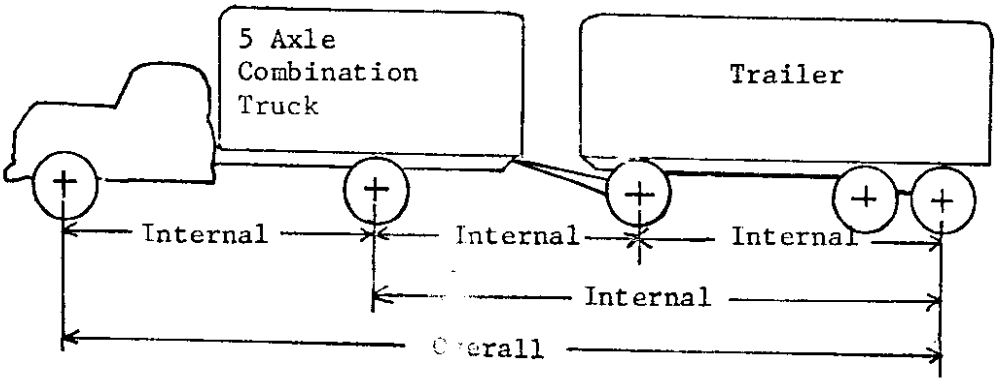

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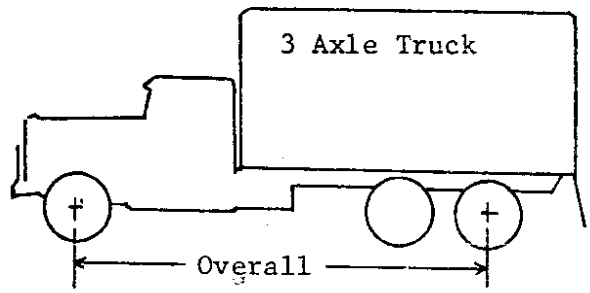

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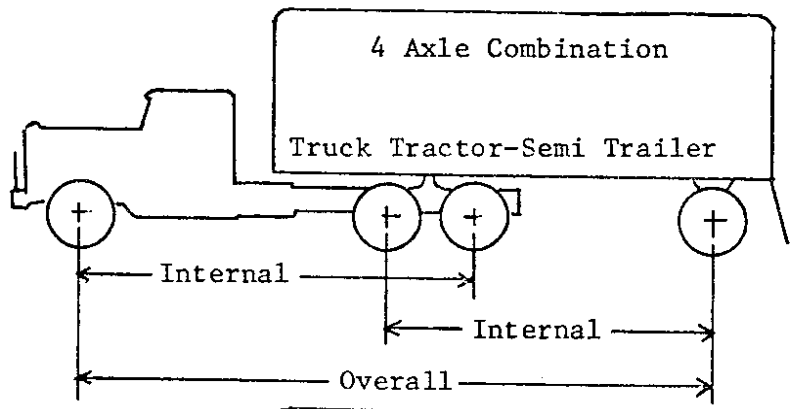

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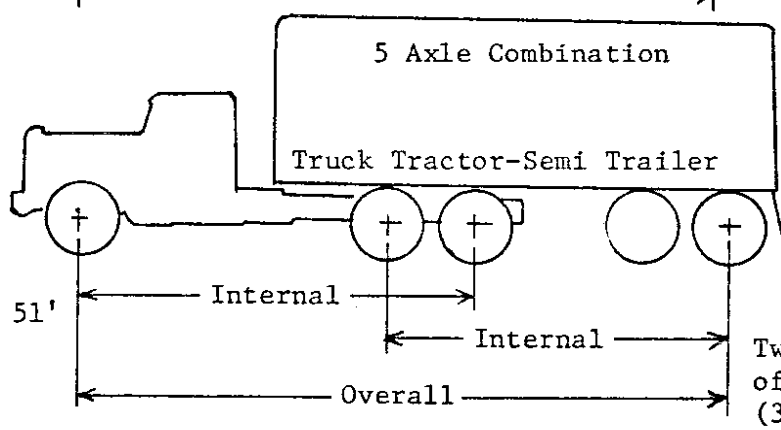
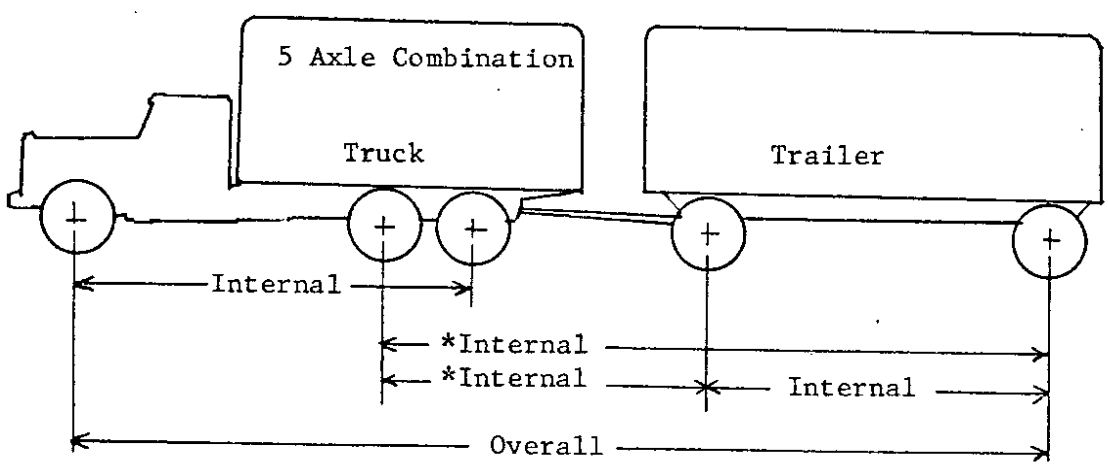


Overall wheelbase of 51' allows 80,000 lbs determined by tire size steering axle

Two consecutive groups of tandem axles (36' allows 68,000 lbs)

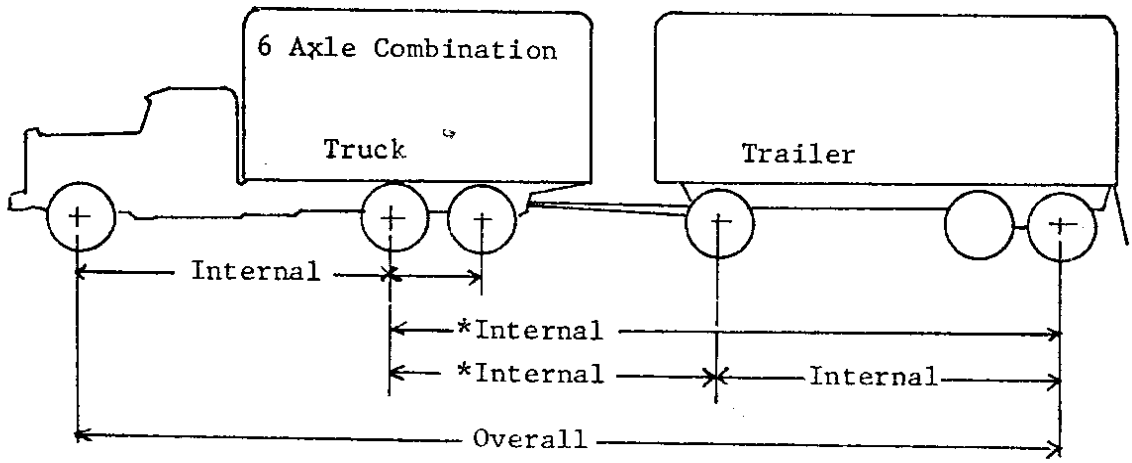
9.



*Indicates the critical measurements

Example: 24' wheelbase from axle 2 to 4 allows by table (3 axle column) 54,000 lbs. 10' wheelbase from axle 4 to 5 allows 40,000 lbs. These two examples for gross weight purposes would be determined by the internal wheelbase from axle 2 to 5. Take the total wheelbase measurement from axle 2 to 5. This would be the critical measurement as 34' from axle 2 to 5 applied to the 4 axle column would allow a gross weight of 63,500 lbs.

10.



*Indicates the critical measurements

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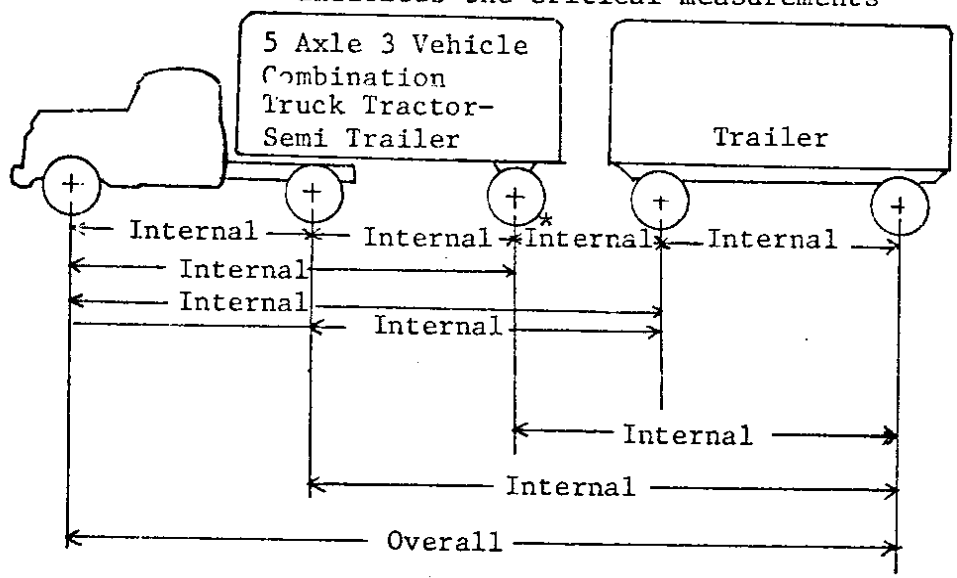

*Indicates the critical measurement

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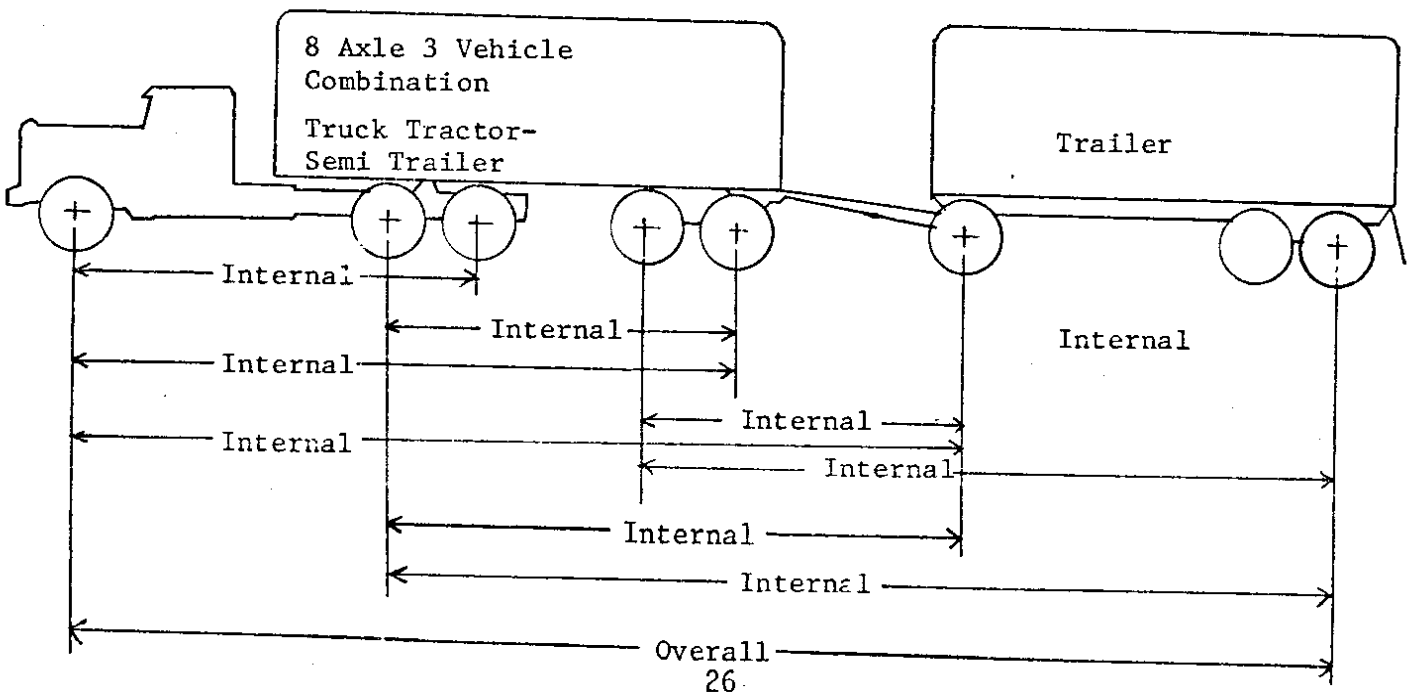

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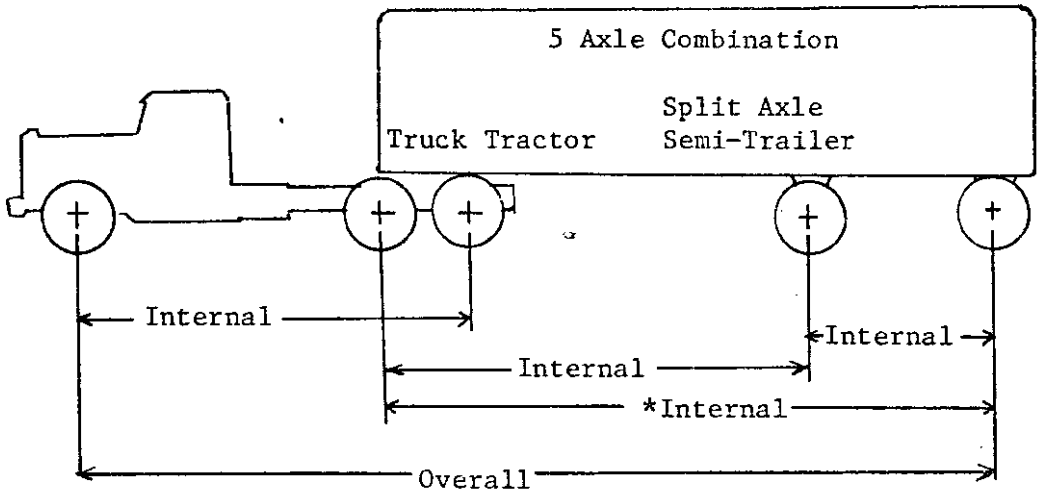

* Indicates the critical measurement

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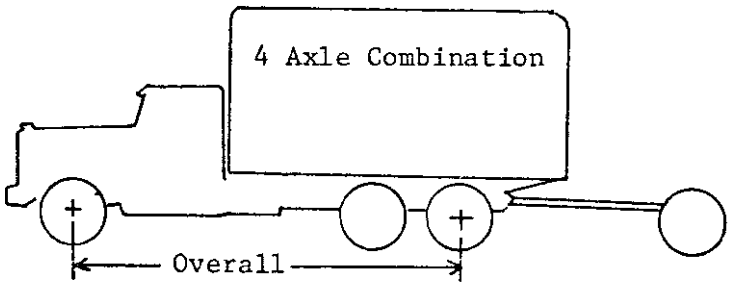

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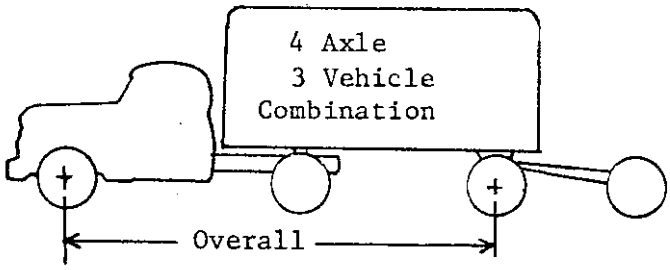

Vehicles towing a dolly axle not designed to support an appreciable part of the load will not be included in the wheelbase measurement for gross combination weight purposes.