Measurement and Analysis of Truck Tire Pressures in Oregon

OK-KEE KIM AND CHRIS A. BELL

As axle loads have increased, the use of higher tire pressures has become more popular in the truck market. To collect data on tire pressures and types of tires in use, a survey was carried out at a weigh station located near Woodburn, Oregon, on Interstate 5 during the summer of 1986. The data show that 87 percent of the tires surveyed are of radial construction. The average measured pressures of radial and bias tires are 102 psi and 82 psi, respectively. The survey results show that the difference between the manufacturer's maximum recommended tire pressure and the measured tire pressure is very small, particularly for radial tires. Therefore, if government agencies wish to control tire pressures, it would be expedient to control the manufacturer's maximum recommended pressure rather than the inflation pressure used by truckers. This would ensure reasonable control, since the data collected in this study show that measured and recommended tire pressures are nearly equal. The survey results show that most tires are 11 in. wide with a rim diameter of 24.5 in. (i.e., 11/80 R 24.5 or 11-24.5) and the average tread depth of radial tires is slightly greater than that of bias tires.

The economics of truck transportation have contributed to an increase in the average gross weight of trucks such that the majority of trucks are operating close to the legal gross loads or axle loads (*1*). Many states, including Oregon (*2*), also issue permits for trucks to operate above normal legal load limits. As axle loads have increased, the use of radial tires with higher pressures has become more popular in the truck market to support the increased axle loads.

Higher tire inflation pressures decrease the contact area, resulting in reduced tire friction or reduced skid resistance and increased potential for pavement damage under the high stress. The higher tire pressures contribute to greater deformation in flexible pavements, manifested as high-severity wheel track rutting. Rutting results in hazardous pavements, since ruts create an uneven pavement where water and ice can accumulate in harsh weather. The higher tire pressures also tend to be accompanied by higher loads, and these will tend to increase the severity of fatigue cracking.

In order to determine the levels of tire pressures in use, a survey was carried out at a weigh station located on Interstate 5 during the summer of 1986 by the Oregon Department of Transportation (ODOT) and Oregon State University (OSU). This paper presents a part of the study on procedures for controlling the effect of increased tire pressure of trucks on asphalt pavement damage (*3*) performed by the ODOT and OSU. It describes existing operating characteristics of Oregon's trucks, particularly levels of tire pressures and tire sizes, and analyzes the survey data.

Department of Civil Engineering, Oregon State University, Corvallis, Oreg. 97331-2302.

BACKGROUND

Economic incentives that often exceed the expected costs of overweighting to the trucker are a major reason for increasing the cargo weight of trucks. The benefit to a trucker from increasing the load capacity of a truck is increased financial returns.

Table 1 indicates that the cash incentive to load 80,000 lb rather than 73,000 lb is $180, and the incentive increases as cargo weight increases (*4*). This results from decreasing costs per ton-mile as cargo weight increases. Figure 1 shows how costs per ton-mile decrease dramatically and costs per mile increase only slightly as the weight of the load increases. As the weight increases from 10 to 25 tons, the cost per ton-mile decreases 60 percent, whereas the cost per mile increases only 1.5 percent. Since fuel cost per mile traveled does not vary proportionately with the weights of trucks, as shown in the Mississippi and Oregon studies (*1*), the more a truck is loaded the greater the financial benefit.

Consequently, the economics of long-haul truck transportation have contributed to the increase in the average gross weight of trucks such that the majority of trucks are operating close to or above the legal gross loads or axle loads. In 1982, the federal government permitted 80,000 lb gross vehicle weight, 20,000 lb single-axle weights, and 34,000 lb tandem-axle weights on Interstate highways.

As axle loads have increased, so have tire pressures, due in part to attempts to decrease the contact area between the tire and the pavement, resulting in reduced rolling resistance of vehicles and, therefore, reduced fuel consumption. A recent study in Texas (*5*) indicates that trucks typically operate with tire pressures of about 100 psi in that state. A study by Roberts and Rosson (*6*) indicated that the contact pressure between the tire and pavement for a bias tire with an inflation pressure of 125 psi could be as high as 200 psi. That study showed that for legal axle loads, increasing the tire pressures from 75 to 125 psi for a bias-ply tire (10.00-20) can cut the life of the typical thin asphalt concrete pavements of Texas by 30 to 80 percent.

Thus, increased tire inflation pressures and axle load configuration are important factors to be considered in asphalt pavement design and rehabilitation strategies (particularly overlay design). Consideration of these factors could result in the refinement of paving mix design and pavement structure design methods, as well as in the

TABLE 1 INCREMENTAL INCENTIVES TO OVERWEIGHT (*4*)

Vehicle Weight (lb)	Cargo Weight (lb)	Rate per Pound* ($)	Resulting Rate ($)	Incentive ($)
73,000	45,000	0.056	2520	0
75,000	47,000	0.054	2540	20
80,000	52,000	0.052	2700	180
90,000	62,000	0.050	3100	580
100,000	72,000	0.048	3460	940

*A typical rate $0.056; the decreases in rate per pound are given in an attempt to account for the rate reduction that might be offered by a trucker planning to overweight.

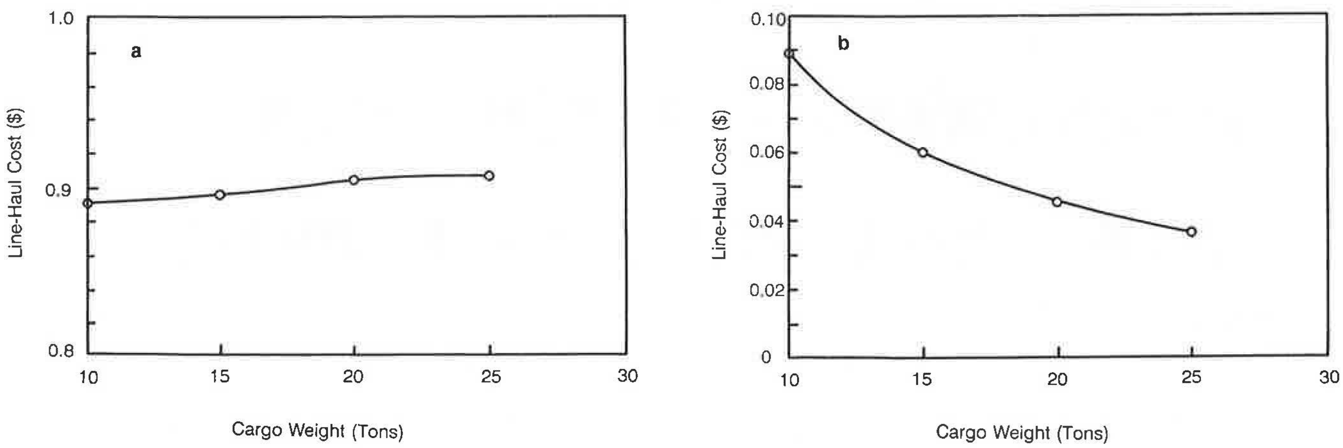


FIGURE 1 Cargo weight vs. line haul cost (*4*): (a) per mile; (b) per ton-mile.

adjustment of highway user costs. Also, highway maintenance schedules should be reviewed and the remaining life of the existing pavements constructed on the basis of truck tire pressures of about 80 psi.

RESULTS

A survey to evaluate tire inflation pressures and types of tires in use was carried out at a weigh station located near Woodburn, Oregon, on Interstate 5 from July 28 to July 30 and from August 25 to August 31, 1986. The data for each truck took about 15 to 30 min for two or three inspectors to collect, depending on the truck type. The survey was performed day and night for the above-mentioned period.

A tire pressure data collection sheet is shown in Figure 2. One data collection form represents one truck, and the form consists of four parts, as follows:

1. Basic data: date, time (start time and finish time), Public Utility Commission (PUC) safety inspection number, inspector, PUC plate number, and commodity;
2. Weather information, including air temperature and pavement temperature;
3. Truck classification used in Oregon's Weigh-in-Motion study;
4. Tire data: axle number, dual/single tire, tire manufacturer, tire construction (radial/bias), tire size, tread depth, and tire pressure [recommended maximum pressure (cold) by manufacturer, first and second measured tire pressure].

The tire manufacturer, tire construction, and tire size were read from the tire. As Middleton et al. (*5*) did in Texas, tire pressure was measured twice. The first measured pressure was the inflation pressure measured after the truck was stopped. The second pressure measurement was the last step of collecting the data. Therefore, a time interval between the first and the second measurement was 15 to 30 min. The reason for the second measurement was to determine whether or not a change in pressure occurred as the tires cooled down.

TIRE PRESSURE DATA COLLECTION SHEET

BASIC DATA: Test No. (no entry required): ______ Date: 08/26/86 Start Time: 9-10A

PUC Safety Inspection No.: 068579 Place of Inspection: Woodburn POE Inspector: ______

PUC Plate No.: AAX 678 Commodity: Forklift parts Comments: ______

WEATHER: (tick one)

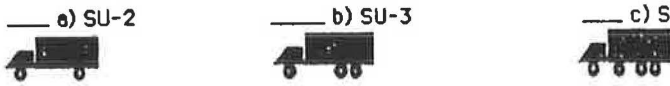
a) Hot & Sunny ___; b) Cool & Sunny X; c) Hot & Cloudy ___; d) Cool & Cloudy ___; e) Intermittent Showers ___; f) Frequent Showers ___; g) Persistent Rain ___

*Air Temperature ___°F *Pavement Temperature 70°F *Record immediately after start time

TRUCK CLASSIFICATION: (tick one)

A. Single Units:

___ a) SU-2 ___ b) SU-3 ___ c) SU-4



B. Trucks & Trailers:

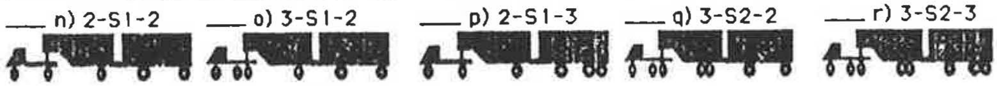
___ d) 2-2 ___ e) 2-3 ___ f) 3-2 ___ g) 2-2-2 ___ h) 2-2-3 ___ i) 3-2-2

C. Tractors & Semitrailers

___ j) 2-S1 ___ k) 3-S1 ___ l) 2-S2 X m) 3-S2

D. Tractors, Semitrailers & Trailers:

___ n) 2-S1-2 ___ o) 3-S1-2 ___ p) 2-S1-3 ___ q) 3-S2-2 ___ r) 3-S2-3



___ s) 3-S2-4 ___ t) 2-S1-2-2 ___ u) 3-S1-2-2 ___ v) 2-S2-3-2 ___ w) 3-S1-2-3

TIRE DATA:

A. Left Side - Outer Tires

Axle #	Twin/Single Tire	Name	Mfr. Rec/Max Pressure (psi)	Rad/Bias (R/B)	Size	Pressure (psi) 1st*/2nd**	Tread Depth†
(1) (strg)	S	1	120	R	A	102/100	13
(2)	D	2	100	R	A	102/102	11
(3)	D	3	120	R	A	92/90	10
(4)	D	4	100	B	B	80/76	8
(5)	D	5	100	B	B	94/94	8
(6)							
(7)							
(8)							
(9)							

B. Right Side - Outer Tires

Axle #	Twin/Single Tire	Name	Mfr. Rec/Max Pressure (psi)	Rad/Bias (R/B)	Size	Pressure (psi) 1st*/2nd**	Tread Depth†
(1) (strg)	S	1	120	R	A	110/110	10
(2)	D	2	100	R	A	90/90	9
(3)	D	3	120	R	A	91/92	7
(4)	D	6	85	B	B	92/90	2
(5)	D	7	85	B	B	96/94	7
(6)							
(7)							
(8)							
(9)							

*measured at beginning of inspection; ** measured at end of inspection; †1/32nd in.

Finish time: 9-35 A

1 Remington
2 Michelin
3 Aurora
4 Dunlop
5 Toyo
6 Firestone
7 Goodrich

A 11R225
B 10.00-20

FIGURE 2 Tire pressure data collection sheet.

TABLE 2 NUMBER OF TRUCKS BY TYPE IN THE SAMPLE

	Truck Type	Frequency	%
Single Units	SU-2	11	4.1
	SU-3	9	3.3
Trucks and Trailers	2-3	2	0.7
	3-2	16	5.9
	3-3	4	1.5
	3-4	3	1.1
	4-4	1	0.4
Tractors and Semi-Trailers	2-S1	12	4.4
	3-S1	3	1.1
	2-S2	11	4.1
	3-S2	151	55.9
	4-S2	1	0.4
	2-S3	1	0.4
	3-S3	1	0.4
Tractors, Semi-Trailers and Trailers	2-S1-2	10	3.7
	3-S1-2	11	4.1
	3-S2-2	3	1.1
	3-S2-3	3	1.1
	3-S2-4	1	0.4
	2-S1-2-2	4	1.5
	3-S1-2-2	2	0.7
	2-S1-2-1	1	0.4
Unknown		9	3.3
TOTAL		270	100

Truck Types

Trucks were classified as shown in Figure 2. As presented in Table 2, of the 270 trucks surveyed, 55.9 percent were 3-S2 (18-wheelers), 7.4 percent were single-unit trucks, and 13 percent were trucks with tractors, semitrailers, and trailers.

Tire Construction

The tires surveyed were divided into three groups:

1. Single tires used for steering axles,
2. Single tires for nonsteering axles, and
3. Dual tires for nonsteering axles.

As presented in Table 3 the data collected show that the majority of tires are radials, i.e., 87 percent of total tires (total is 2,704 tires). Radial tires constitute 91 percent of tires used for steering axles, which is the greatest percentage among the three groups.

Recommended Maximum Tire Pressure

Figure 3 shows the distribution of the recommended maximum tire pressure (cold) by manufacturers for three groups of radial and bias tires, and Table 3 presents the mean value and one standard deviation. The averages of recommended maximum pressure for dual radial and bias tires are 101 psi and 81 psi, respectively.

Measured Tire Pressure

Figure 4 shows the distribution of the first measured tire pressure for three groups of radial and bias tires. Table 3 presents the mean value and one standard deviation of the first measured tire pressure and the difference between the first and the second measured tire pressures. The averages of the first measured pressure of dual radial and bias tires are 102 and 82 psi, respectively. The first measured tire pressures are slightly higher by 1.2 to 2.4 psi than the second measured pressures.

TABLE 3 RESULTS OF TIRE SURVEY

	Single Tire for Steering Axle		Single Tire for Non-Steering Axle		Dual Tire for Non-Steering Axle	
	Radial	Bias	Radial	Bias	Radial	Bias
A. Tire Construction						
Sample Number	499	46	91	11	1755	292
Sample Frequency, %	91.5	8.5	89.2	10.8	85.7	14.3
B. Recommended Tire Pressure						
Mean	106	84	108	84	101	81
One Standard Deviation (psi)	7	9	14	4	8	8
Sample Number	495	46	89	11	1735	285
C. 1st Measured Tire Pressure						
Mean (psi)	106	86	107	93	102	82
One Standard Deviation (psi)	10	17	15	10	12	15
Sample Number	498	46	91	11	1755	292
D. (1st Measurement)-(2nd Measurement)						
Mean (psi)	1.5	2.4	1.6	1.5	1.2	1.6
One Standard Deviation (psi)	2.3	2	1.9	0.7	3	2.7
Sample Number	316	18	66	2	1064	202
E. Tread Depth (1/32-in.)						
Mean	13	11	12	12	11	9
One Standard Deviation	3.4	3.7	4.3	3.7	4.9	3.4
Sample Number	496	46	88	11	746	287

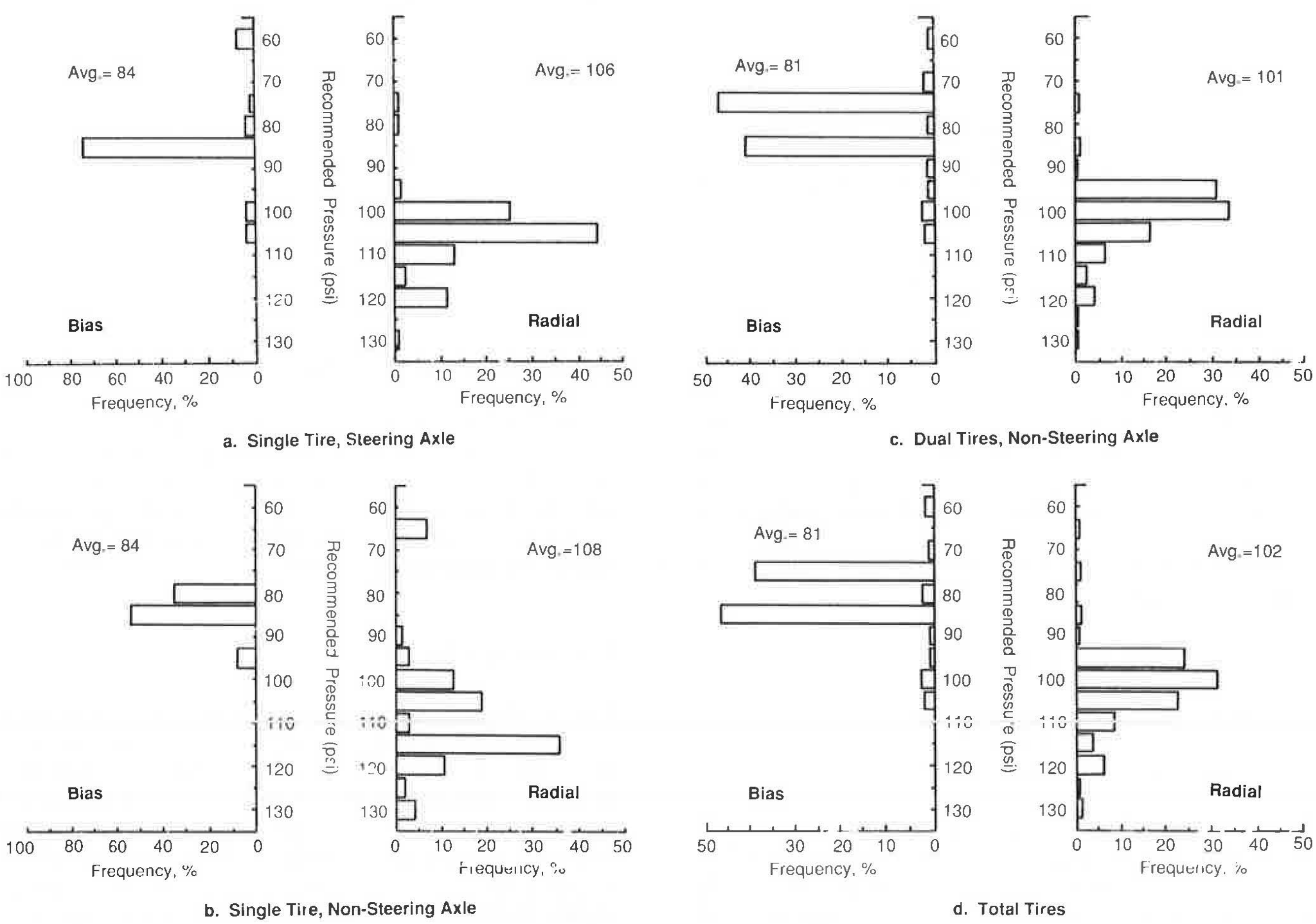


FIGURE 3 Distribution of the recommended tire pressure.

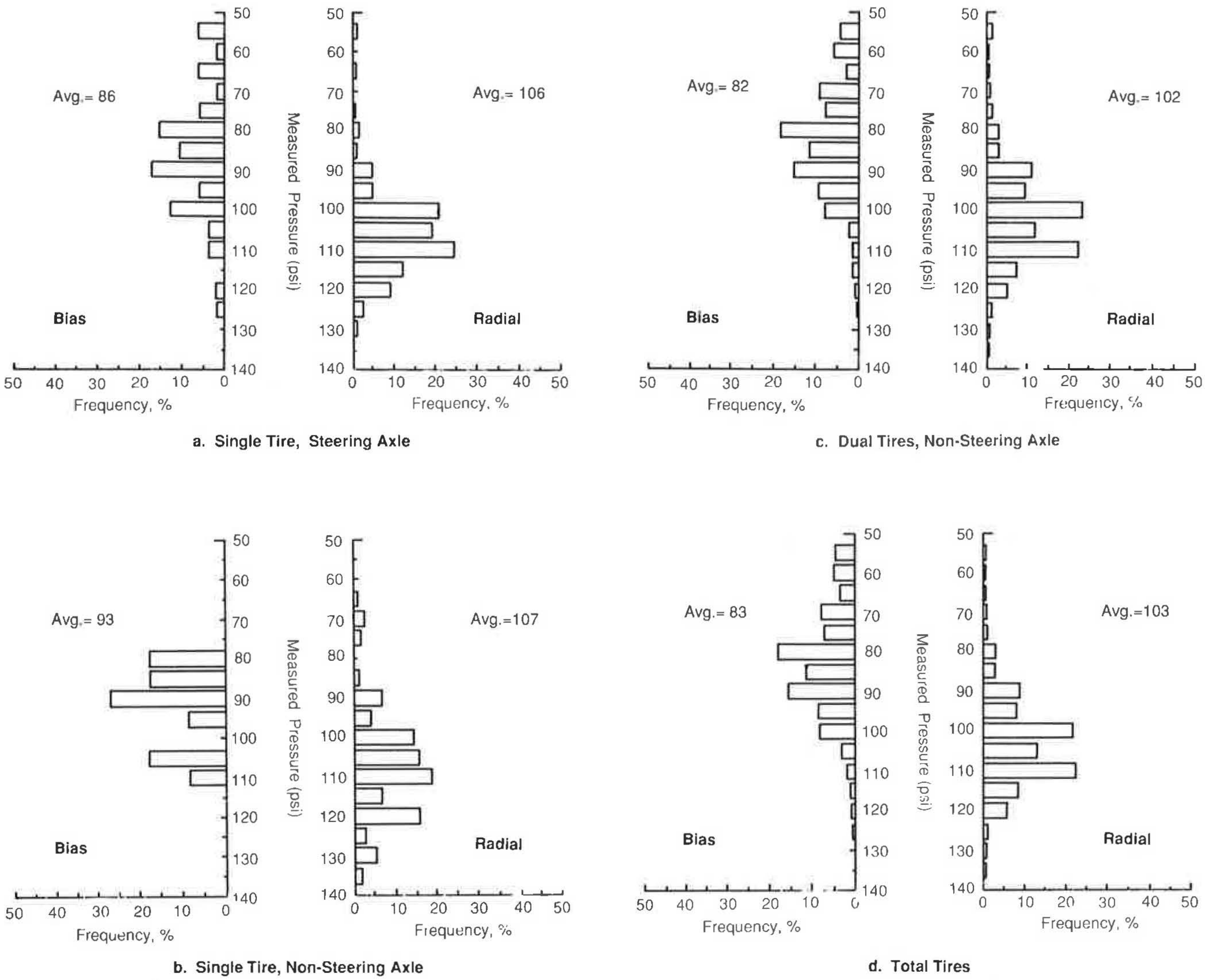


FIGURE 4 Distribution of the measured tire pressure.

Tread Depth

Figure 5 and Table 3 present the results of the tread depth survey. The average tread depth for radial tires used for steering axles is $^{13}/_{32}$ in. This is the highest tread depth among the groups. The average tread depth for bias dual tires used for nonsteering axles is $^{9}/_{32}$ in. This is the lowest measured tread depth.

Tire Size

Table 4 presents the distribution of tire size for radial and bias tires. The major tire size for radials is 11/80 R 24.5. However, for the single tire for nonsteering axles, the major tire size is 12 R 22.5, which is slightly wider than 11/80 R 24.5. The major tires sizes for bias are 11-24.5 and 10.00-20 as presented in Table 4b. It should be noted that 13.2 percent of single radial tires used for nonsteering axles are 15 R 22.5, i.e., 15-in.-wide tires, which are wider than the major tire sizes.

Figure 6 (*7*) shows the description of tire dimensional information used in truck tire sizing nomenclature. For example, 11/80 R 24.5 means that the size of the tire is 11 in. wide, has an aspect ratio of 0.8 (section height/section width, see Figure 7), radial, and rim diameter of 24.5 in. Bias ply tires are designated with a hyphen in place of the R.

More detailed data on tire size are presented by Kim et al. (*3*).

Manufacturer

Table 5 presents the distribution of the eight manufacturers surveyed for radial and bias tires. One company, which supplies 28 percent of the radial tires, did not produce any bias tires. More detailed data on tire manufacturers are presented by Kim et al. (*3*).

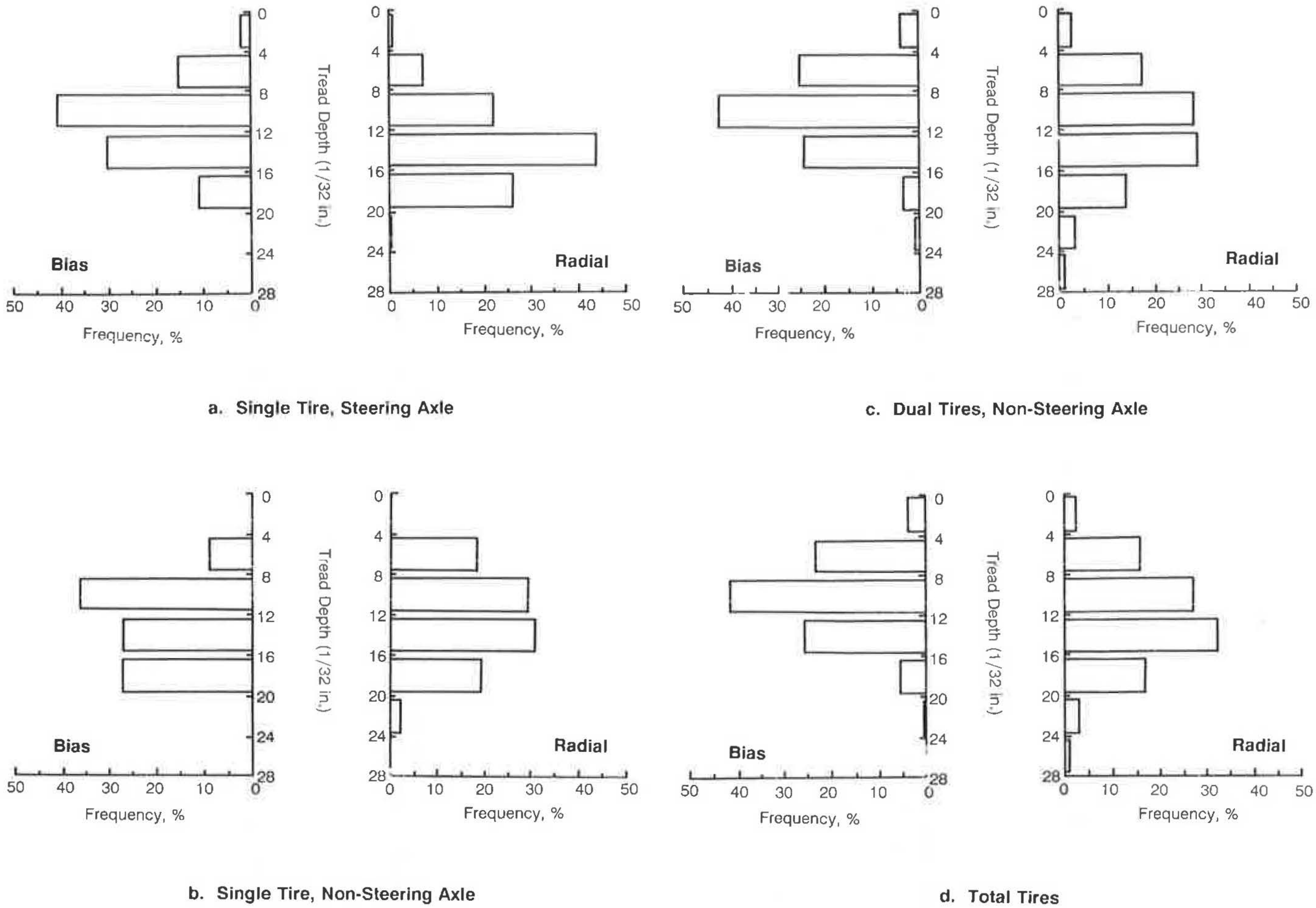


FIGURE 5 Distribution of tread depth.

DISCUSSION OF RESULTS

As expected, the majority of tires were of radial construction. As presented in Table 5, one company which supplies 28 percent of the radial tires did not produce any bias tires. There may be several reasons that bias tires have been replaced with radial tires, as outlined below.

From the 1970s, the trucking industry increased their use of radial truck tires as tire service demands on medium and heavy trucks increased. Testing done on bias and radial tires with similar tread designs from the same manufacturer confirmed that the radial tire generally offered improvements over the bias, as presented in Table 6 (*8*).

As mentioned earlier, the federal government permitted 80,000 lb gross vehicle weight and 34,000 lb tandem-axle weights on Interstate highways in 1982. This allowed a potential 12,000-lb load on the steering axle. Most states invoke a restriction on the load per inch width of tire of 600 lb, i.e., two 10-in.-wide tires could legally support a 12,000-lb axle load. According to Cooper (*8*), two bias tires in the commonly used sizes and standard 12-ply rating do not have 12,000-lb capacity, but two standard 14-ply-rating radial tires which allow the higher inflation pressure necessary for a higher capacity rating do carry over 12,000 lb. The improved loading capacity and the advantages presented in Table 6 are some of the reasons that have led to an increase in radial truck tire usage. Wong (*9*) indicated that for a radial ply tire on a hard surface, there is a relatively uniform ground pressure over the whole contact area. In contrast, the ground pressure for a bias ply tire varies greatly from point to point as tread elements passing through the contact area undergo a complex localized wiping motion. However, the effect of different tire construction on asphalt pavements is still not well known.

As shown in Table 3, the average of the recommended tire pressure of single tires (for steering axles and nonsteering axles) is higher than that of dual tires. The same trend is apparent in the first measured tire pressure distribution in Table 3. Therefore, the data show that truckers tend to use higher tire pressure (i.e., higher rated tires) for a single tire for steering axles as well as nonsteering axles than for dual tires for nonsteering axles.

As indicated in Table 3, the first measured tire pressure is slightly higher than the second measured one. For radial tires, the difference between the first measurement and the second measurement is smaller than that for bias tires except in the case of single tires for nonsteering axles.

For radial tires, Table 3 and Figures 4 and 5 show that truckers tend to use the manufacturer's maximum recommended tire pressure. This is due to operation safety and efficiency. For bias single tires with nonsteering axle, the

TABLE 4 TIRE SIZE DISTRIBUTION (%)

(a) Radial Tire

Tire Size	Single Tire on Steering Axle	Single Tire on Non-Steering Axle	Dual Tire on Non-Steering Axle
11/80 R 24.5	46.5	15.4	49.1
11 R 22.5	22.2	19.8	21.1
285/75 R 24.5	9.6	1.1	7.1
275/80 R 24.5	6.1	3.3	3.9
275/80 R 22.5	3.9	-	4.1
12 R 22.5	2.0	33.0	2.2
10.00 R 22	2.0	-	3.9
15 R 22.5	-	13.2	-
Others	7.7	14.2	8.6
Number in Sample	490	91	1737

(b) Bias Tire

Tire Size	Single Tire on Steering Axle	Single Tire on Non-Steering Axle	Dual Tire on Non-Steering Axle
11-24.5	30.8	-	30.8
10.00-20	15.4	36.4	29.8
10.00-22	11.5	18.1	21.2
11-22.5	17.3	-	9.9
9.00-20	3.8	45.5	2.6
Others	21.2	0.0	5.8
Number in Sample	52	11	302

average of the measured pressure is higher by about 10 psi than that of the recommended maximum pressure, but the sample size of 11 tires is very small.

As shown in Table 7, the difference between recommended pressure and measured pressure for radial tires is almost zero. However, for bias tires, the inflated pressure is greater than the recommended pressure. As presented in Table 3, radial tire pressure is higher by 20 psi than bias tire pressure. The study performed by Middleton et al. (*5*) indicated that radial tires on the average showed 12 to 21 psi higher pressure than did bias tires.

If government agencies wish to control tire pressures, it would be expedient to control the manufacturer's maximum recommended pressure rather than the inflation pressure used by truckers. This would ensure reasonable control, since the data collected in this study show that measured and recommended tire pressures are nearly equal.

In general, higher-inflation-pressure tires have deeper tread depth as presented in Table 3. This implies that operators may use higher pressures with newer tires.

Recently, the trucking and tire industries have started to promote super single radials and new low-profile (or low-aspect-ratio) tubeless tires. The concept of replacing dual tires with a wide single is not new but has gained popularity recently in the long-haul market. As mentioned in the earlier section, 13.2 percent of single tires used for nonsteering axles are 15 R 22.5 (Table 4a). According to the restriction of 600 lb per in. width of tire, two tires 15 in. wide can support 18,000 lb, that is, the equivalent standard single-axle load used in pavement design by many states.

New super single radial tires are claimed to have 10 percent or better tread mileage and 8 to 10 percent better fuel economy than conventional dual radials (*10*). Also, the lighter weight of the wide-base single tire assembly permits higher payloads. The reduced tire aspect ratio decreases tire deflection, thereby improving vehicle handling and stability while increasing tread life and fuel economy. However, the effect of the super single tire on the performance of asphalt pavement needs more study. The pressure data collected indicate that the mean pressure of the whole sample is similar to that found in the Texas study (*5*) and is considerably higher than that traditionally used in pavement design (i.e., 80 psi). Since

NUMERIC (TWO PART):

7.00 — Approx. Cross Section Width in Inches
R — Radial Construction *
15 — Rim Diameter In Inches
LT — Light Truck application

ALPHANUMERIC:

H — Tire Size/Load
R — Radial Const.
78 — Series (Aspect Ratio)
– 15 — Rim Diameter In Inches
LT — Light Truck application

METRIC:

LT — Light Truck
235 — Tire Section Width (MM)
/85 — Aspect Ratio
R — Radial Const. *
16 — Rim Diameter
E — Load Range

THREE PART (FLOTATION SIZING):

26 — Overall Diam. In Inches
x 8.50 — Approx. Cross Section Width In Inches
R — Radial Const. *
14 — Rim Diam. In Inches
LT — Light Truck application

*Bias ply designated with a hyphen in place of "R".

FIGURE 6 Tire sizing designation (7).

the study described herein and other studies have confirmed that a wide variety of tires and pressures are used, it is necessary to refine paving mix design and pavement structure design methods to account for the prevailing levels of tire pressure. Also, the remaining life of existing asphalt pavements or maintenance schedules on the section having high truck traffic may need adjustment because the increased truck tire pressure may result in severe damage.

The factor of truck tire pressure, as well as axle loads, could be a consideration in setting registration fees and fine schedules.

However, caution is advised when considering the effects of tire pressures on asphalt pavements for, say, 80 psi (a typical tire pressure in the 1960s) with 100 psi (a typical tire pressure in the 1980s) because the former were almost exclusively bias tires and the latter are predominantly radial tires.

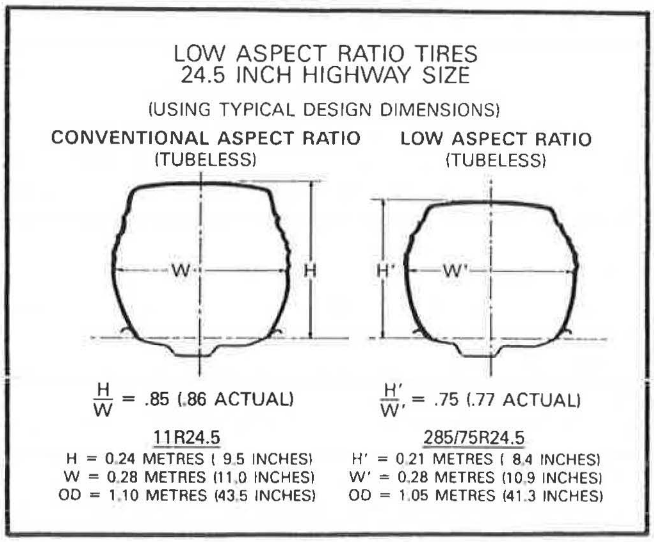


FIGURE 7 Comparison of conventional and low-aspect-ratio tires (8).

CONCLUSIONS AND RECOMMENDATIONS

The existing operating characteristics of Oregon's trucks, including levels of tire pressures, were surveyed and analyzed. The major findings and conclusions of this study are:

1. As expected, the use of radial tires is dominant. Eighty-seven percent of the tires surveyed were of radial construction. The bias tires used may be replaced with radial tires in the future.
2. The average measured pressures of radial and bias tires are 102 and 82 psi, respectively. Therefore, adequate consideration of current levels of tire pressure should be reflected in paving mix design, pavement structure design methods including overlay design, and maintenance schedules.
3. Since the difference between the recommended maximum tire pressure by manufacturer and the measured tire pressure is very small, it can be said that truckers tend to use the recommended maximum pressure (cold) for reasons of operating safety and efficiency.
4. The sizes of most radial tires are 11/80 R 24.5 and 11-24.5, respectively.
5. The average tread depth of radial tires is slightly greater than that of bias tires.

In order to control the effect of increased tire pressure on asphalt concrete pavement, the following recommendations are made:

1. If government agencies wish to control tire pressures, it would be expedient to control the manufacturer's maximum recommended tire pressure (cold) rather than the inflation pressures used by truckers, since the data collected in this study show that measured and recommended tire pressures are nearly equal.
2. For overload permits, fees, and fine schedules, the levels of tire pressure might be included in assigning appropriate cost responsibility after an investigation into the effect of higher tire pressures on the asphalt pavements is performed.

ACKNOWLEDGMENTS

This paper presents the results from an HP and R (Highway Planning and Research) study, conducted by the Oregon State Highway Division and Oregon State University in cooperation with the Federal Highway Administration. Special appreciation is given to Ken Evert and his staff, who collected tire pressure data (total of about 2,700 tires) day and night during the summer of 1986.

TABLE 5 DISTRIBUTION OF RADIAL AND BIAS TIRES BY TIRE MANUFACTURER

(a) Radial Tire

	Single Tire on Steering Axle	Single Tire on Non-Steering Axle	Dual Tire on Non-Steering Axle
1. Michelin	25.0	36.3	28.4
2. Goodyear	22.0	11.0	22.7
3. Bridgestone	15.5	24.2	15.0
4. Toyo	9.7	15.4	9.6
5. Kelly	3.6	2.2	4.0
6. Yokohama	3.8	1.1	3.0
7. Firestone	2.2	1.1	2.8
8. OHTSU	3.6	1.1	1.7
Others	14.6	7.6	12.8
Number in Sample	496	91	1755

(b) Bias Tire

	Single Tire on Steering Axle	Single Tire on Non-Steering Axle	Dual Tire on Non-Steering Axle
1. Goodyear	10.9	30.0	23.2
2. Firestone	6.5	-	9.5
3. Goodrich	10.9	20.0	6.7
4. Bridgestone	-	-	7.7
5. General	-	10.0	7.0
6. Multimile	8.7	-	3.5
7. Dunlop	4.3	0	3.9
8. OHTSU	8.7	20.0	2.1
Others	50.0	20.0	36.4
Number in Sample	46	10	284

TABLE 6 COMPARISON OF BIAS AND RADIAL TIRE PERFORMANCE (*8*)

Property	Type Test	Bias Tire	Radial Tire
Wear Rate	Proving Grounds	Par	Better
Wear Regularity	Proving Grounds	Par	More Sensitive
Running Temperature	Laboratory	Par	Better (Lower)
Fuel Economy	Proving Grounds	Par	Better (6% Savings)
Tire Noise	SAE J57A	Par	Better (3 dBA Less)
Puncture Resistance	Commercial Fleet	Par	Better (40% Fewer)

TABLE 7 MEAN VALUES OF DIFFERENCE BETWEEN RECOMMENDED TIRE PRESSURE AND FIRST MEASURED PRESSURE

	Single Tire on Steering Axle		Single Tire on Non-Steering Axle		Dual Tire on Non-Steering Axle	
	Radial	Bias	Radial	Bias	Radial	Bias
Mean (%)	0.3	2.5	-0.2	10.0	1.3	2.2
Standard Deviation (%)	10.7	14.6	8.0	9.6	12.9	19.9
Number of Tires	495	44	89	11	1734	285

$$\frac{\text{Measured Pressure - Recommended Pressure}}{\text{Recommended Pressure}} \times 100\%$$

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