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Wet Traction of Tractionized Tires

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A. H. Neill, Jr.

Office of Vehicle Systems Research
National Bureau of Standards
Washington, D.C. 20234

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WET TRACTION OF TRACTIONIZED TIRES*

A. H. Neill, Jr.

A series of dynamic vehicle tests was performed at NBS to evaluate the performance of tractionized or siped tires. Stopping distance and lateral breakaway data is presented from a two wheel diagonally braked automobile which clearly shows that siped tires do not represent any improvement in the lateral stability or stopping distance characteristics of a typical passenger automobile.

Key words: Siping; stability; stopping distance tires; traction; tractionizing.

1. Introduction

For many years a process known as siping, or tractionizing, has been widely publicized as a means of increasing traction at the tire-road interface. The process is said to offer great improvement in stopping distance, lateral breakaway, and driving traction especially under wet conditions. The purpose of this paper is to present the results of tests carried out by NBS for the National Highway Traffic Safety Administration to test these claims. The reader is also referred to a paper by Domandl [1] which presents longitudinal friction data from a skid trailer and is complementary to the results arrived at in this work.

Several methods of siping tires have been presented to the public. Two of the most representative methods were chosen for evaluation by NBS. In method A, the tire is taken off the car, placed on a hub and axle, trued, and then cuts are made in each rib of the tire, eight cuts per inch at a depth of 5/32 to 6/32 at 90^{o} to the angle of rotation. In the second, method B, the tire is cut with seven sipes per inch at a depth of 7/32 (new tires) to 4/32 (well worn) at an angle of 65^{o} to the direction of rotation.

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In order to facilitate understanding, the paper is divided into two sections, one for siping method A, the other for siping method B.

2. Method A

Sixteen belted bias tires were chosen for this portion of the tests. Eight new tires were broken in for 100 miles. The remainder were worn under actual driving conditions to a depth of 0.298 inch in the inner groove, 0.326 inch in the outer groove which took 8000 vehicle miles. The assumption was that if 16 tires all of the same tread design and compound were used, any deviations in the results must be due to either tire wear, siping, or a combination of the two.

The tests were run on four different surfaces with different skid numbers [2]. Pavements 2, 4, and 5 were used for stopping distance tests, and 1 and 2 were used from the J-curves. In table 1 a description of the skid pads is presented and the skid values as defined in ASTM E-274-69 are listed in a range of speeds from 20 to 50 mph.

The surfaces offered a wide range of coefficients and surfacing materials used on today's highways. A standard 500 gallon watering truck with a 12-foot watering bar was used to keep the surfaces wet at a depth of approximately 0.05 inch. One pass was made before each skid by the truck. The exact depth of the water could not be determined because of differences in the textures of the pavements. The same volume of water was used on each pad.

The four sets of tires were chosen at random as were the order of pads and speeds for each set. However, one tire set remained on the car for all the stopping distance tests before the next set was run. The J-curve tests were run in the same manner. Thus any drifts in coefficient or changes due to ambient temperature would be minimized. All tires were statically balanced and in addition the siped tires were also trued, i.e., high spots cut off to make the tire round.

The stopping distance data was taken under two wheel diagonal braking on a specially instrumented 1968 Chevrolet loaded to 1270 lb/wheel. This allowed the driver to retain control of the car and provided a result which was independent of spinning or lateral acceleration. A digital readout gave the distance traveled from the point of full lock-up. Figure 1 is a graphical representation of the data in table 2 for each skid pad. Although there is a significant difference in stopping distance between surfaces there is insufficient evidence to support the hypothesis that siped tires stop in a shorter distance than unsiped tires. Only on pad 2 is there a slight indication that siped tires may perform significantly better than unsiped tires. In the four instances showing improvement, the greatest margin is less than 18 percent. The coefficient of variation for this portion of the tests, method A, was less than 12 percent.

In order to check for any improvement in lateral breakaway, tests were run on two surfaces, pad 1 and pad 2. These were in the form of a J-curve with a radius of curvature of 288 ft. The results are given in table 3 for these tests. Again no significant differences were seen between the siped and the unsiped tires. It should be noted however that the unsiped tires appear slightly better than the siped. This is not significant in terms of the magnitudes involved.

3. Method B

Since no real difference was found between the new and old tires on any of the pads or at any speeds, eight new bias belted tires identical to the ones in method A were used in this portion of the tests. As described above, tires with sipes at an angle of 65° to the direction of rotation were now evaluated to check their performance.

In table 4, results are presented which clearly show that the siped tires are again not better or worse than the unsiped tires. The improvement noted on pad 2 was significant in one case and the greatest significance was less than 10 percent. The coefficient of variation is less than 17 percent. In figure 2, (a) and (b) represent data taken some 3 weeks before the data shown in (c), (d), and (e). Each data point is the average of four runs.

Table 5 gives the results of the lateral acceleration tests as described in method A. Again no significant improvement was noted; instead a consistent average one mph difference is observable showing the unsiped performance to be better than that of the siped. The lateral acceleration as measured by accelerometers mounted on the sprung mass of the car give relative lateral forces induced in the tires just before breakaway. This data is presented to show comparative lateral forces. It is not the maximum lateral acceleration but bears a linear relationship to it.

The ambient temperature varied within a range of from 73° to 87°F with the mean at 81°F for all the tests.

4. Conclusions

The data above represents a series of tests in which an effort was made to verify the statement that siped tires represent a real improvement in stopping distance and lateral control. The results as presented in this paper do not verify this contention. In two separate experiments on three different occasions the data clearly shows that on a variety of surfaces, from extremely slick to highly abrasive, the performance of a real vehicle does not become any more stable or conversely less stable with the use of tractionized, or siped, tires.

In the lateral breakaway tests where an improvement was expected from the 65° siping process, method B, a consistent one mph degradation of breakaway speed was noted.

Thus it is clear that the process known as tractionizing, or siping, does not offer a significant improvement in vehicle stability. Only one type of tire was used in this evaluation because it was felt that the range of structures and compounds available in today's tires would not cause enough of a difference in the movement of the contact patch to create a significant difference in the total vehicle performance. The improvements noted on pad 2 represent a small percentage of the total results and the number of roads resembling pad 2 is quite small.

5. Acknowledgments

The author wishes to express his gratitude to Messrs. Peter Newfeld and Perry Rawlins who did all the vehicle testing. Likewise to Messrs. G. Shute and R. Zimmer for the system of instrumentation and Mr. A. Kondo for his statistical analysis of the results.

6. References

[1] Domandl, H., Some friction data on Microsiped tires, Report S-27, Pennsylvania State University, University Park, Penn. (March 1968).

[2] Stocker, A. J., et al, Tractional characteristics of automobile tires (report on NBS Contract CST-451). Available from the National Technical Information Service (formerly Clearinghouse), Springfield, Va. 22151, Accession No. PB 189 272.

Table 1. Skid pad characterization

Pavement No.	Description	SN Value: Stopping Distance Pads (50-20 mph)	SN Value: J-Curve Pads (40 mph)
1	Rounded Silicous Gravel	42-46	50
2	Crushed Silicous Gravel	43-49	51
4	Slag and Limestone Screenings	7-18	24
5	Rounded Silicous Gravel (P.C. Concrete)	42-61	43

Table 2. Stopping distance, method A: each value represents average of four runs
Skidding data (in feet)

Pad 2

mph/	20	30	40	50
Old siped	38.0	102.8	177.5	268.0
Old unsiped	46.3	98.5	204.5	315.8
New siped	41.8	100.5	187.3	294.5
New unsiped	43.8	100.8	192.0	295.5

Pad 4

mph/	10	20	30	40
Old siped	19.3	72.5	197.5	387.3
Old unsiped	15.8	76.3	185.0	383.5
New siped	17.8	77.0	205.3	393.5
New unsiped	18.0	83.0	211.8	395.0

Pad 5

mph/	20	30	40	50
Old siped	46.5	104.8	215.0	330.0
Old unsiped	42.8	107.5	205.5	321.3
New siped	47.5	109.3	208.3	330.5
New unsiped	46.0	110.5	207.3	340.5

Table 3. Lateral breakaway speed, method A

	Pad 1	Pad 2
New	41.2 mph	43.7 mph
New siped	40.2	43.0
Used	42.3	43.8
Used siped	42.0	43.9

Table 4. Stopping distance, method B: each value represents average of four runs

Skidding data (in feet)

Speed (mph)	October 2, 1970 Unsiped	October 2, 1970 Siped	October 28, 1970 Unsiped	October 28, 1970 Siped
Pad 2				
10	-	-	10	10
20	41	40	40	42
30	100	90	94	93
40	190	184	182	176
50	303	296	308	294
Pad 4				
10	-	-	20	21
20	-	-	97	99
30	-	-	238	247
40	-	-	453	461
Pad 5				
10	-	-	10	10
20	46	45	40	46
30	110	108	98	118
40	202	218	184	208
50	334	347	316	347

Table 5. Lateral breakaway speed, method B

Tire	Pad	Speed at Spinout (mph)	Max Lateral Acceleration Before Spinout (g)	Speed Just Below Spinout (mph)	Max Lateral Acceleration Just Before Spinout (g)
Unsiped	2	42	0.625	41	0.65
	4	39	.50	38	.50
		40	.475		
		40	.50		
	5	42	.70	41	.70
		42	.725		
Siped	2	42	.65	40	.580
		41	.625	39	.55
		41	.625		
	4	38	.525	37	.50
			.550		
	5	41	.65	40	.62
		41	.65	40	.63
				40	.65

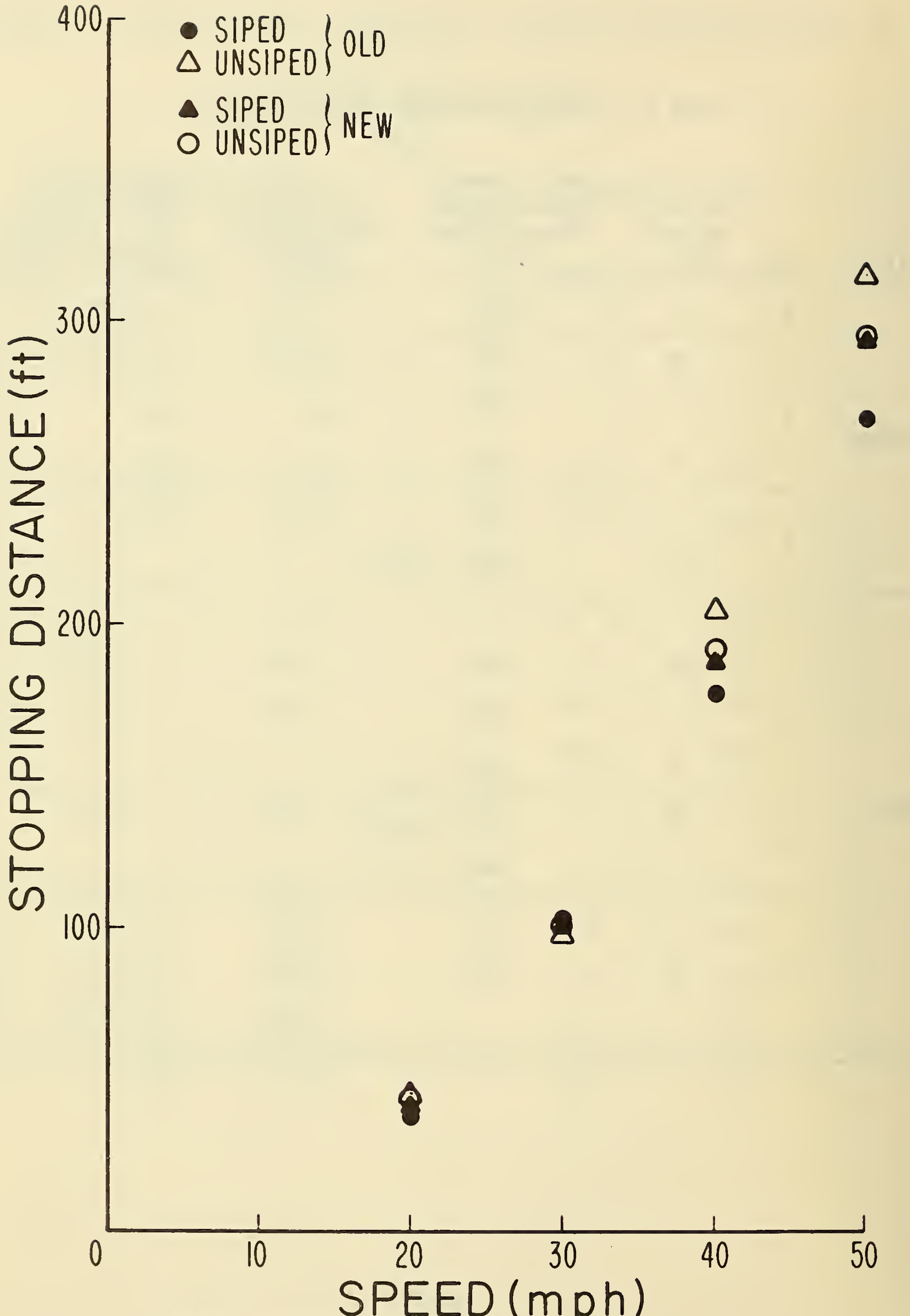

Figure 1. Distance traveled from the point of full lock-up. (a) Pad 2

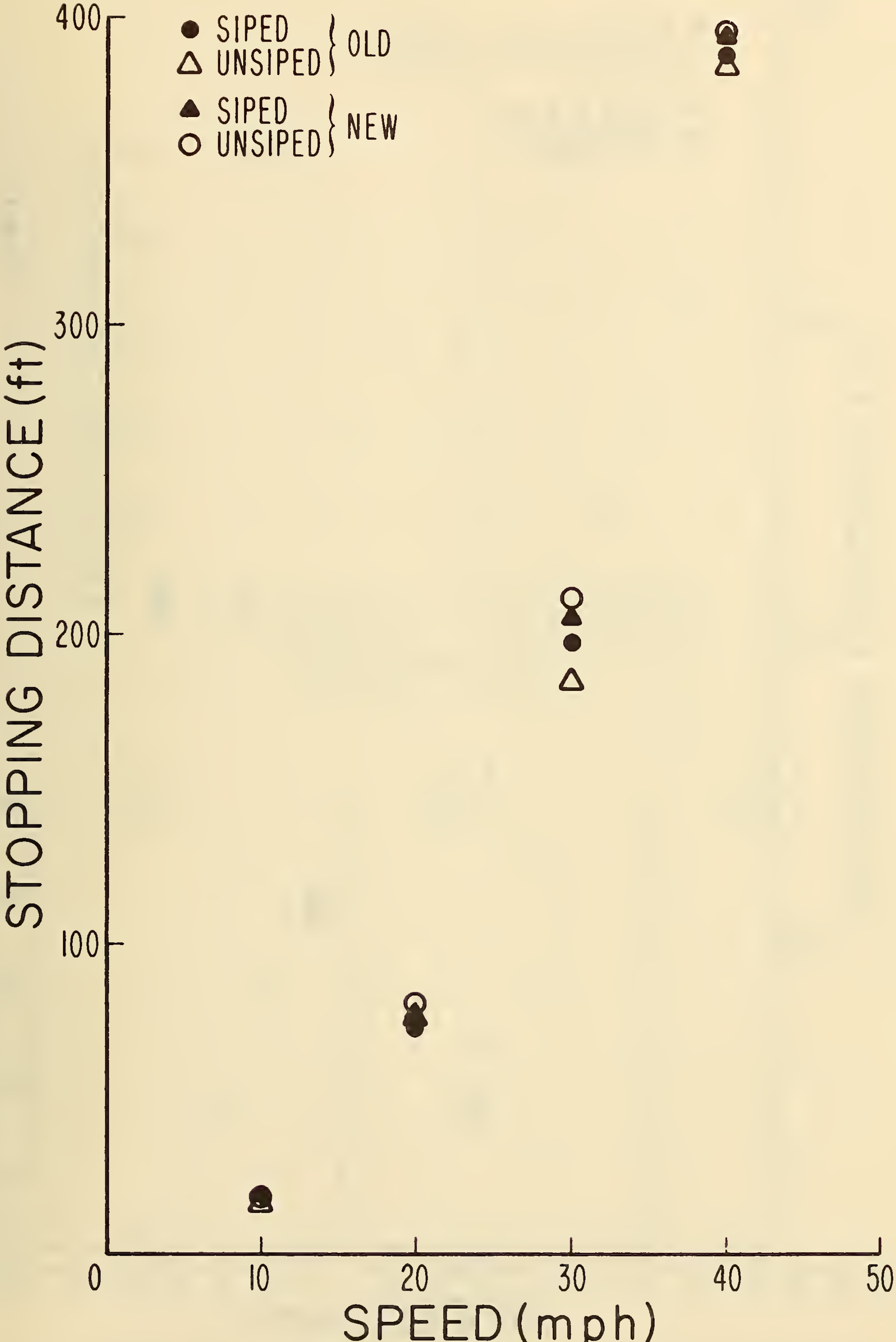

Figure 1. (b) Pad 4

Figure 1. (c) Pad 5

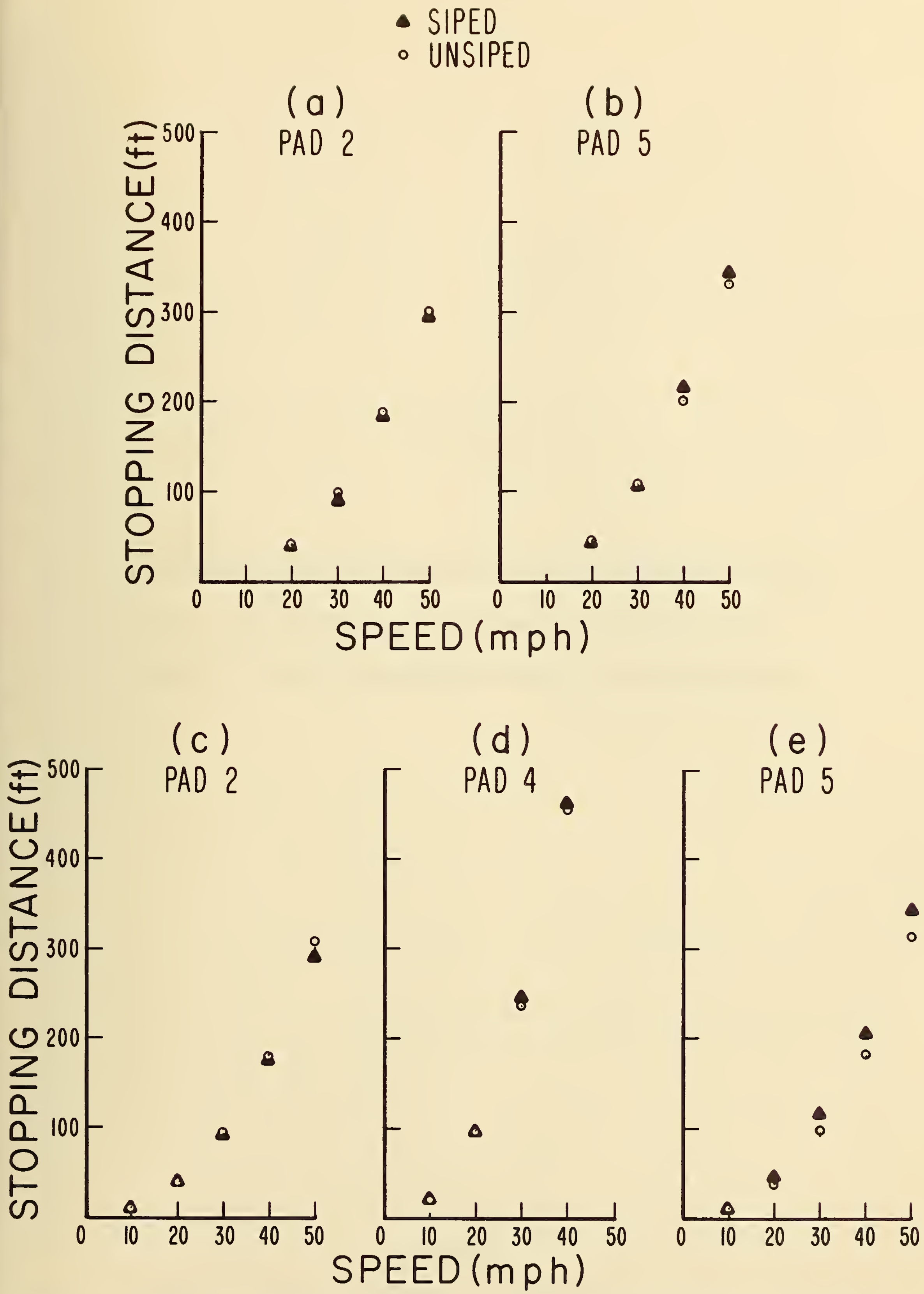

Figure 2. Stopping distance, method B, siped and unsiped tires (table 4).

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