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Technical Report

Investigation of the Rolling Resistance of Fuel-Efficient and High Performance Tires

By

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Foreward

A second phase of the Rolling Resistance Test Program was to determine the rolling resistance of two groups of tires:

Group 1 - those tires thought, on the basis of advertising and promotional claims, to be low rolling resistance (and thus fuel efficient), and

Group 2 - those tires thought (on the same grounds) to be "high performance" tires.

Tests were performed to learn if tires advertised as fuel-efficient had lower rolling resistance than the high sales tires previously sampled, and to determine if the high performance tires had higher rolling resistance than regular performance automobile tires. This report presents the test results of the above two groups of tires.

I. Tire Selection Criteria

Some of the desired models were located by searching through periodicals for tires advertised as: 1) low rolling resistance or fuel efficient, and 2) high performance. If only a manufacturer name was given in the advertisement, the manufacturer was called for recommendations. One model was chosen because it had performed well in a previous test program. In addition, fifteen high performance models were volunteered for testing by the California State Office of Procurement. (They wished to consider rolling resistance data from this program in the procurement of tires for the California Highway Patrol.) All models except those volunteered by the California State Office of Procurement, were purchased at retail stores in the Ann Arbor area.

Selection of tires for this portion of the program was restricted by test capacity. Approximately 45 tests remained from the total allocated testing capacity. Because of this restriction, and because two previous test programs [1,2] showed good homogeneity among tires of one model, only two tires from each model selected were purchased. The California State Office of Procurement sent three tires from each model for testing. Such small sample sizes sacrifice some statistical accuracy; however, this was deemed acceptable on the basis of previous findings. [1,2]

All tires tested in this portion of the program were of radial-ply construction and 14-inch nominal diameter (except three models donated from the California State Office of Procurement). However, it was not possible to obtain all tires with the same aspect ratio and section width. All tires were purchased as close to the size P195/75R14 as possible.

II. Test Contractor

As with the previous portion of this program, the actual testing was conducted by Standards Testing Laboratories, Inc. (STL) of Massillon, Ohio. STL has had extensive experience in tire testing, and provided consistent test results for the previous portion of the program.

III. Test Procedure

The test procedure used was the spindle-force method described in "EPA Recommended Practice for the Determination of the Rolling Resistance Coefficients."[3] This procedure is outlined in the accompanying report EPA-AA-SDSB-84-5, "Characterization of the Rolling Resistance of Aftermarket Passenger Car Tires."

IV. Results

Mean RRC was computed for each model within the two groups. The results for each group were then compared to those obtained for the radials tested in the previous part of the program. Group 1 tires were expected to have lower rolling resistance than the radials from the previous test matrix, since the previously tested radials were purchased about one year earlier and tire technology can be assumed to have improved since then, and since these tires were specifically chosen because of their advertised low rolling resistance. Conversely, it was expected that the tires of Group 2 would likely sacrifice rolling resistance, and hence some fuel economy benefits, in exchange for performance.

Finally, to investigate the consistency of the results, the coefficient of variation (standard deviation divided by mean RRC) was examined for each model line.

A. Group 1 - Low Rolling Resistance/Fuel Efficient Tires

The overall mean rolling resistance coefficient (RRC) for Group 1 tires was only slightly lower than the mean RRC for the previously tested group of tires. The overall mean RRC for Group 1 tires, 0.011307, was only 1.0×10^{-6} lower than the overall mean RRC of 0.011308 for the 170 radial tires tested in the previous program. The percentage difference between Group 1 and the 170 radials from the other matrix was only 0.0088 percent. The wide range of mean RRC values in Group 1 accounts for the proximity of mean RRC for Group 1 to the mean of the tires of the previously tested. Mean RRC for models in Group 1 ranged from 0.0087 to 0.0127. Three models had excellent rolling resistance and thus lowered the overall mean considerably: Bridgestone RD-116, Bridgestone RD-108, and Toyo 714. The remaining five models had only mediocre rolling resistance and raised significantly the overall mean RRC of Group 1. Table 1 lists mean rolling resistance force, mean RRC (in increasing order), and the standard deviations of each model.

B. Group 2 - High Performance Tires

The high performance tires generally had considerably higher rolling resistance than the previously tested tires. The mean RRC for the 27 high performance tires tested was 0.0136, 17 percent higher than the mean RRC of 0.0113 for the previous matrix. Table 2 lists the results for Group 2 in order of increasing mean RRC.

One should note the low rolling resistance of the Firestone Super 125. The difference between the mean RRC of the Firestone Super 125 and the mean RRC of the other tires in Group 2 is certainly significant, and this model definitely lowered the overall mean RRC of this group.

C. Consistency of Results

To determine the consistency of our results, we examined the coefficient of variation of the models in Group 1 and Group 2. The coefficient of variation ranged from 0.0104 percent to 16.6 percent, with a mean coefficient of variation of 2.04 percent. Since 16.6 percent coefficient of variation is nearly five times the next highest coefficient of variation (3.52 percent), the "outlier" having the coefficient of variation of 16.6 percent (Bridgestone RD-108) was deleted. Without the RD-108, the mean coefficient of variation for all models tested is 1.2 percent, which agrees well with the mean coefficient of variation from the previous matrix of 1.5 percent. These figures signify that despite the small sample size used in the analysis, the results (with the exception of the RD-108s) were both very consistent and comparable to previous results.

V. Conclusions

Based upon this examination of eight supposedly fuel-efficient, low rolling resistance models, it was determined that the majority tested did not have substantially lower rolling resistance than did the tires of the same construction type previously tested. Three models, however,

Table 1

Group 1 Rolling Resistance Data - Means by Brand and Model

Brand and Model	N	Size	Rolling Resistance Force (lbf)		RRC	
			$\bar{x}$ [1]	s [2]	$\bar{x}$	s
Bridgestone RD-116	2	185/70SR14	8.06	0.0919	0.00872	0.00011
Bridgestone RD-108	2	175/70SR14	10.25	1.7112	0.01040	0.00174
Toyo 714	2	195/70HR14	10.88	0.0990	0.01063	0.00011
Pirelli P8	2	165/65R14	9.06	0.2334	0.01167	0.00032
Montgomery Ward Gas Miser	2	P195/75R14	13.36	0.1414	0.01193	0.00011
Continental TS 771	2	195/70SR14	13.01	0.0990	0.01213	0.00008
BF Goodrich Arizonian	2	P195/75R14	13.73	0.3748	0.01227	0.00033
Dunlop Elite 70	2	P205/70R14	14.59	0.0424	0.01273	0.00004
Combined	16		11.62	2.3506	0.01131	0.00135

[1] x = mean
[2] s = standard deviation

Table 2

Group 2 Rolling Resistance Data - Means by Brand and Model

Brand and Model	N	Size	Rolling Resistance Force (lbf)		RRC	
			x̄ [1]	s [2]	x̄	s
Firestone Super 125[3]	3	P225/70R15	15.18	0.2214	0.01093	0.00019
BF Goodrich Pursuit [3]	3	P225/70R15	17.60	0.5640	0.01254	0.00044
BF Goodrich Comp T/A	2	205/70VR14	15.72	0.0495	0.01318	0.00003
Avon Turbospeed	2	205/70HR14	15.86	0.0707	0.01331	0.00001
Kelly-Springfield Charger 65	2	P215/65HR14	15.41	0.0191	0.01335	0.00017
Goodyear NCT60	2	185/60HR14	12.49	0.1344	0.01394	0.00014
BF Goodrich Pursuit[3]	3	P205/70R14	15.99	0.0058	0.01395	0.00001
Goodyear Eagle[3]	3	P205/70HR14	16.04	0.2685	0.01401	0.00024
Armstrong Turbo ETX[3]	3	P225/70HR15	19.94	0.3403	0.01422	0.00025
Yokohama 352	2	195/60HR14	14.07	0.0990	0.01550	0.00013
Pirelli P7	2	205/55R14	14.99	0.0919	0.01658	0.00010
Combined	27		15.97	1.8879	0.01364	0.00145

[1] x = mean
[2] s = standard deviation
[3] This model line volunteered for testing by the California State Office of Procurement.

did have excellent rolling resistance. The investigation of 11 high performance tire models revealed that, on the average, these tires have approximately 17 percent higher rolling resistance than regular performance tires. Thus, it appears possible that one sacrifices some fuel economy with the use of high performance tires. The variations observed in the analysis of "low rolling resistance" tires and of high performance tires were consistent with those results obtained in the previous part of the program.

References

1. "Characterization of the Rolling Resistance of Aftermarket Passenger Car Tires," Nancy Egeler, U.S. EPA Technical Report No. EPA-AA-SDSB-84, July 1984.

2. "Rolling Resistance Measurements - 106 Passenger Car Tires," Gayle Klemer, U.S. EPA Technical Report No. EPA-AA-SDSB-81-03, August 1981.

3. "EPA Recommended Practice for the Determination of the Rolling Resistance Coefficients," Glenn D. Thompson, U.S. EPA-SDSB, March 1980 amended August 1980.

4. "The Measurement of Passenger Car Tire Rolling Resistance," SAE Information Report J1270, October 1979.