U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

RESEARCH PAPER RP1574

Part of Journal of Research of the National Bureau of Standards, Volume 32, February 1944

MEASURING THE RATE OF WEAR OF TIRE TREADS

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ABSTRACT

The rates of wear of different tread materials were determined by weighing tires after running them prescribed distances on the roads. The method proved feasible for passenger car tires, involved a minimum amount of work, and yielded data in a few miles of driving which could be used to predict the life of the tread. This paper presents typical results obtained on five different tread materials, including prewar natural rubber treads. The rate of wear of the least resistant tread material was eight times that of the most resistant material.

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I. INTRODUCTION

During the height of the emergency period, when many possible materials were being considered for the treads of pneumatic tires, this Bureau was called upon to make measurements on the rate of wear of several of these materials. Since few tires and even fewer test cars were available, and early results were desired, it was necessary to obtain a reasonably precise and reliable measure of the tread wear during relatively few miles of driving. There are two obvious methods of determining the loss of tread rubber from a tire: (1) by measuring the groove depths in the tread design at intervals, and (2) by weighing the tire at intervals.

The first method requires measurements of groove depths at many places on the tire. Since the depths of the grooves in most new passenger car tires are only $\frac{3}{8}$ inch or less and are not uniform in many tread designs, it is clearly difficult, by this method to obtain any reliable prediction about the life of the tread until an appreciable portion of the rubber has been worn away.

The second method, namely, weighing the tire at intervals, was chosen because of the greater precision obtained by its use. The weight of a tire can be determined to within 1 or 2 grams, and about 2,000 grams of tread-rubber are worn away during the life of the tread. Observations of tread wear for these several materials were continued after the preliminary predictions of the tread lives had been made. The results obtained showed that this method was feasible for evaluat-

ing passenger car tires and indicated the effect of other details, such as the location of the tires on the car and the alinement of the wheels. The data presented in this paper illustrate typical results on five different tread materials, including prewar natural rubber treads. The rate of wear of the least resistant tread material was eight times that of the most resistant material.

II. METHOD OF DETERMINING THE RATE OF TREAD WEAR

The tires reported on in this paper were four-ply, size 6.00–16, with highway design treads. Some were recaps and some were new tires. A tire with tube was mounted on a wheel, and the whole assembly was weighed on an equal-arm balance. The weight of a mounted tire and wheel was in the neighborhood of 20,000 grams, and the precision of weighing was 1 gram. The air pressure was always adjusted to 32 lb/in.^{2}, with the tire at room temperature previous to weighing. The wheel assemblies were placed on a test car, and after running them prescribed distances were removed and weighed. For most tires the loss of weight was determined at from 100- to 300-mile intervals, and for some, where the loss was small, at 500- to 1,000-mile intervals.

Usually the tire and wheel were merely brushed clean before weighing them. When it was necessary to wash off mud and dirt, the tires were dried in a warm room (100° F) for about 2 hours before weighing. Judging from the consistency of successive weighings, this washing had little effect on the weight. By using a reference tire and making weighings over a period of 15 months, a gradual change in weight from season to season was noted. The weight was greatest in October and least in March. The difference was about 20 grams and could be attributed to relatively high and low humidities. Such changes in weight due to changes in humidity were small compared with the loss in weight due to wear.

III. CONDITIONS OF TEST

Most of the results reported are based on tests made on a Studebaker Champion coach (abbreviated STUD), but some were made on a Ford coach and a few on a Chevrolet station wagon (abbreviated CHEV). The loads carried by the first two cars varied with the number of passengers. The load carried by the Chevrolet was approximately constant. The loads were as follows:

STUD	Front tires	775 to 800 pounds.
	Rear tires	770 to 910 pounds.
FORD	Front tires	approximately 870 pounds.
	Rear tires	approximately 935 pounds.
CHEV	Front tires	approximately 885 pounds.
	Rear tires	approximately 935 pounds.

The speeds were moderate and seldom exceeded 40 mph. Air pressures were maintained at approximately 32 lb/in^2. The tires were not run over the same route, but the general character of the roads was the same. They were paved for the most part and consisted partly of concrete and partly of macadam. Tests were made at periods between April 1942 and September 1943. More exact dates are given on the graphs for particular tires.

IV. RESULTS

The results of tests are shown in figures 1, 2, and 3. Five different tread materials are considered (1) 100-percent reclaimed rubber, (2) butyl rubber, (3) Flexon, a modified butyl rubber, (4) GR–S type synthetic rubber, and (5) natural rubber.

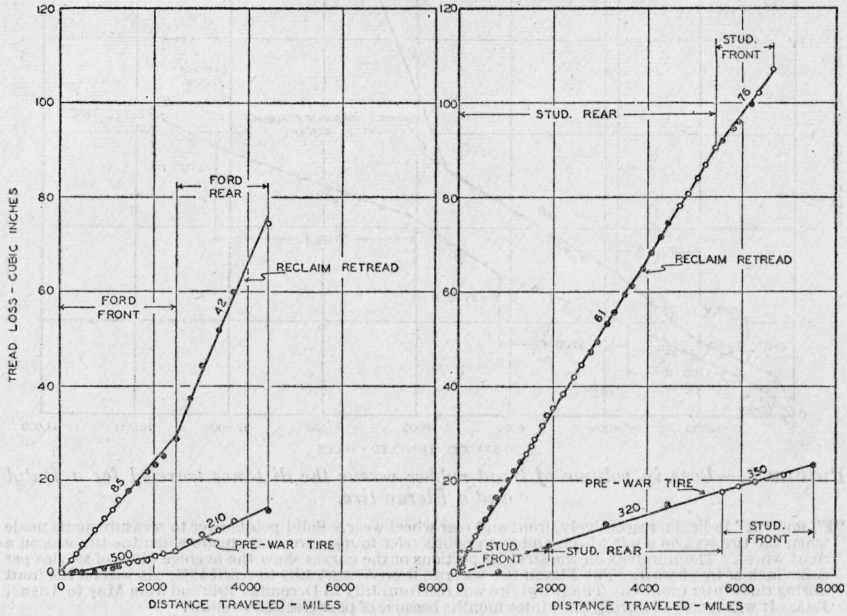

FIGURE 1.—*Loss in volume of tread rubber versus the distance traveled for two 100 percent reclaim recaps and two prewar natural rubber tires.*

Solid points refer to measurements made when the tire was on a left wheel, and open points refer to measurements made when the tire was on a right wheel. The numbers on the straight portions of the curves show the average miles of service per cubic inch of tread wear. The tires were run between April and September 1942.

Because the specific gravities of the tread materials differed, the losses in weight were converted to losses in volume, and these values are plotted against the miles run. The specific gravities as measured were: reclaim, 1.28; butyl rubber, 1.13; Flexon, 1.17; GR–S type, 1.18; natural rubber, 1.14. Lines show the average rate of wear under each test condition, and a number shows the reciprocal of this rate in miles per cubic inch of rubber. The range of these values is given in table 1.

TABLE 1.—*Range of values for different treads*

Kind of tread	Miles per cubic inch of tread wear [a]
Prewar (natural rubber)	210 to 350 [b]
GR–S type	210 to 320
Butyl rubber	150 to 280
Flexon	120 to 260
Reclaim	42 to 85

[a] For a 6.00–16 tire there are usually about 100 cubic inches of tread available, so that the figures in the table may be multiplied by 100 to obtain an approximation of the total miles of service from a tread.

[b] The value of 500 miles obtained for the front wheel of the Ford (fig. 1) was probably due to exceptionally favorable conditions.

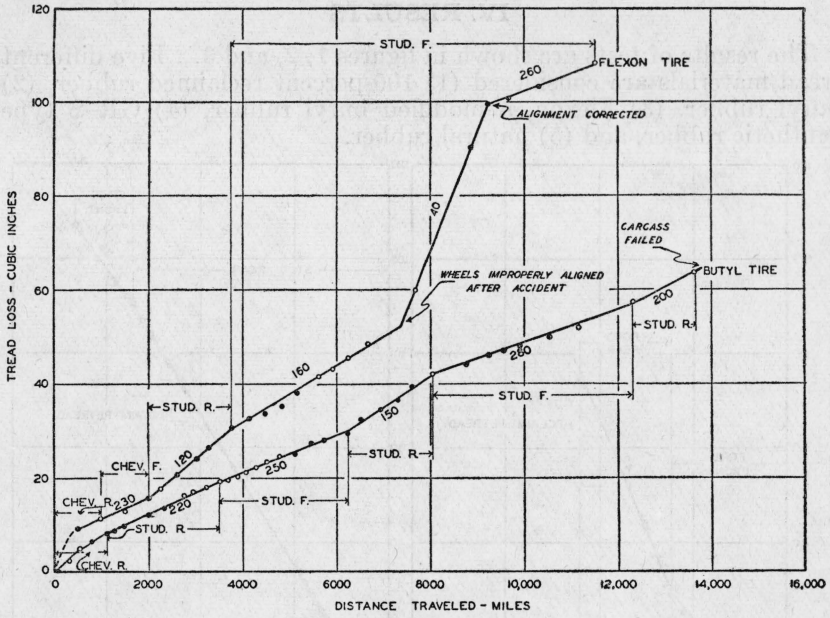

FIGURE 2.—*Loss in volume of tread rubber versus the distance traveled for a Butyl and a Flexon tire.*

"F" and "R" indicate, respectively, front and rear wheel wear. Solid points refer to measurements made when the tire was on a left wheel, and open points refer to measurements made when the tire was on a right wheel. The numbers on the straight portions of the curves show the average miles of service per cubic inch of tread wear. The Flexon tire was run from August 1942 to April 1943. It was on the front during the winter months. The Butyl tire was run from July to December 1942 and from May to August 1943. It was removed during the winter months because of poor traction in snow.

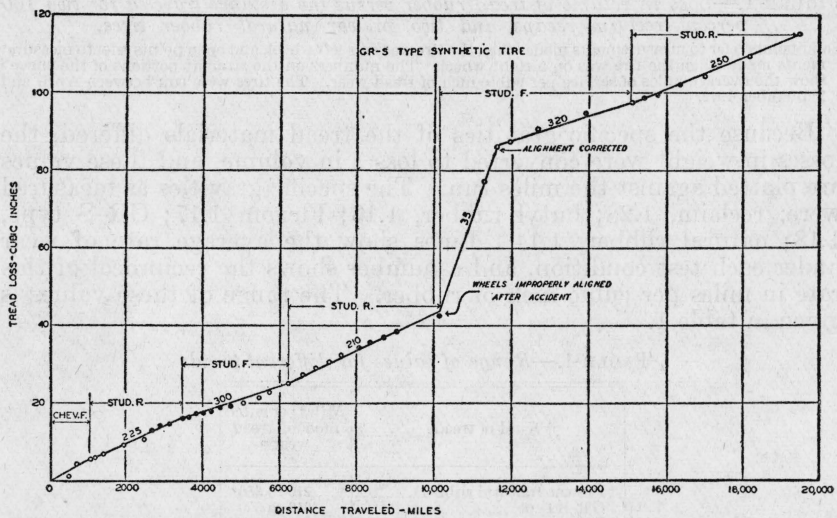

FIGURE 3.—*Loss in volume of tread rubber versus the distance traveled for a GR–S type synthetic tire.*

"F" and "R" indicate, respectively, front and rear wheel wear. Solid points refer to measurements made when the tire was on a left wheel, and open points refer to measurements made when the tire was on a right wheel. The numbers on the straight portion of the curves show the average miles of service per cubic inch of tread wear. The tire was run from July 1942 to September 1943.

A record of the daily temperatures was kept during the time some of the tires were being run, and an attempt was made to correlate wear with temperature. No marked difference was found in the rate of wear during periods of relatively high or low temperatures.

V. CONCLUSIONS

The method of determining the rate of wear of tire treads by weighing the tire and wheel at intervals and noting the loss in weight has been found feasible for passenger car tires.

Data on the rate of wear can be obtained from a tire which has run comparatively few miles.

This method is quite sensitive in showing up features that influence wear, such as differences between front and rear wheels and the effect of misalinement.

WASHINGTON, November 24, 1943.