B

INVESTIGATION OF TIRE WEAR

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The United States Bureau of Public Roads and the University of Kansas have been cooperating upon a project the purpose of which is to determine the relative effect of the various road surfaces upon the tread wear of motor vehicle tires. While the actual time spent upon the project has not been great and the difficulties in the way of rapidly securing data are many, it is now possible to state some preliminary findings and to show clearly the purpose and ultimate value of the research.

The economic value of the various road surfaces depends chiefly upon their construction cost, their maintenance cost and their effect upon the cost of operating motor vehicles over them. The relative value of the various road surfaces could be expressed very closely in terms of the capitalized cost per 100 vehicles per day per year of providing and maintaining the road and operating the vehicles over it if sufficient data were available to supply the details. Since tire cost is one of the important items in motor vehicle operating costs it is clear that the successful completion of the tire wear project will furnish a necessary element toward the above-mentioned economic evaluation. The purpose, then, of this investigation is not only the determination of the relative effect of the various surfaces upon tire wear but the finding of a money value to assign to each

The relation of tread wear to tire cost is an important question. Do tires fail due to tread wear or due to carcass weakness? Tire manufacturers are of the opinion that at present the carcass is developed ahead of the tread and that the normal failure of a tire is by tread wear and not by carcass failure Since it is probably that tread wear is the normal failure for tires running over improved surfaces it is significant that as the general program of road improvement advances the ratio of improved to unimproved road tire mileage will increase rapidly.

The original program of the tire wear test contemplated a combined field and laboratory investigation. For the field work a representative car and tire equipment was to be selected and run at determined speeds over typical level stretches of the various road surfaces. The laboratory work was to supplement and relieve the more expensive field work.

A Dodge touring car equipped with 32 by 4 inch high-pressure cord tires or 30 by 5 77 inch balloon tires is used. High pressure tires are run at the manufacturers' recommended inflation, viz, 65 and 55 pounds, respectively, for the two makes used. Balloon tires are inflated to 24 pounds in front and 26 pounds in the rear.

A "run" consists usually of traveling up and down a selected level stretch of road of suitable length, say 10 miles, for a distance of 500 miles The tires are dried as nearly as practicable to constant weight before and after a run and the loss in weight recorded. Record is kept of both air and tire surface temperature taken at frequent intervals. None but dry road surfaces are used. The car carries an average load and so far has been run only at 25 miles per hour.

The original program contemplated running about 2,000 miles over each of the standard road surfaces such as brick, concrete, asphalt types, bituminous macadam, gravel and sand clay The mileage to date is shown in Table I.

TABLE I

MILEAGE ON VARIOUS TYPES OF ROADS

Type	Tire equipment	
	High Pressure	Balloon
Concrete	1,753	855
Gravel	755	
Bituminous Macadam	1,489	
Monolithic Brick	499	
Bituminous Filled Brick	1,411	441

Since the project was started balloon tires have advanced from the experimental stage to the point of wide adoption and the program has been expanded accordingly.

THE RELATIVE EFFECT OF THE VARIOUS SURFACES

Since all tires used have been taken one or more times over concrete pavements it is possible to adopt it as a base and to assign to it a wear index of 1.00. Then if each tire be taken in turn and its loss by wear over concrete be taken as 1 00, an index may be found for each surface type over which it was tested. The average of all such indices may be taken as the final index value and thus the individual characteristics of tires eliminated.

The following results obtained from Tire No 6 are given as an illustration

TABLE II

COMPARATIVE INDICES FROM TIRE NO 6

No	Road surface	Loss in grams per 500 miles	Comparative index
1	Concrete	15	1 00
2	Concrete	16	1 00
3	Monolithic brick	16	1 00
4	Iowa gravel	60	3 90
5	Chert gravel	128	8 20
6	Bituminous macadam (unsealed)	261	16 80

The above index values averaged with those obtained from other tires have been used to make up Table III, which summarizes all of the results obtained in the field so far

TABLE III

TIRE WEAR INDICES FOR VARIOUS ROAD SURFACES

No	Road surface	Front	Rear	Weighted average
1	Concrete	1 00	1 00	1 00
2	Monolithic brick	1 10	0 97	1 01
3	Bituminous filled brick	1 08	0 95	1 00
4	Iowa gravel	1 10	2 72	2 20
5	Chert gravel	5 90	8 00	7 30
6	Bituminous macadam (unsealed)	9 70	11 1	10 60

Indices for front and rear tires are kept separate It is noted that while the indices for front tires agree quite closely for well-conditioned surfaces, for the rougher surfaces they appear to be inconsistent It may be reasoned that the bounding and spinning of wheels running over the rougher surfaces would produce relatively greater wear in the rear tires There is, however, an abundance of evidence to the contrary in the data so far obtained

Since front tire wear is less than rear tire wear, 50 to 75 per cent of it, and since the mechanical connections of front tire wheels are difficult to maintain, when determining an average for front and rear tire wear the indices were given a weight of 1 and 2, respectively

Run No 6, Table III, shows the effect of roughness and sharp protruding aggregate in a bituminous macadam road upon the wear of inside and outside tires The road was too rough to be considered typical of its type and the results are not included elsewhere The center third was somewhat rough and fairly well sealed while the two outer thirds were rougher and so poorly sealed as to expose a considerable amount of the fine flint aggregate to contact with the tires In running up and down the stretch the inside tires were of course always on the inside and smoother third while the outside tires were exposed to the rougher portions of the pavement. The results furnish convincing evidence of the necessity for smoothness as well as the thorough sealing of this type of surface.

TIRE OPERATING COSTS

The data obtained will now be used to show how such information, when finally brought into such shape to be truly representative of the average vehicle and tire equipment, may be used in the final evaluation of road surfaces.

The data so far obtained shows, for the equipment and method used, that the average loss in weight per tire on concrete pavement is about 60 grams per 1,000 miles. It will be assumed that the average amount of tread rubber available for wear in a 32 by 4 inch high-pressure cord tire is 3 pounds, or 1,360 grams Dividing 1,360 by 60 gives 22600 as the available mileage per tire If the cost per tire be taken as $30, then tire cost per car per mile becomes $0.00532, and the annual tire operating cost per 100 vehicles per day equals $191.50, or say, $200. The following schedule was computed by using $200 as the annual cost figure for concrete and the indices given in Table II. Interest is taken at 5 per cent

TABLE IV

TIRE OPERATING COSTS ON VARIOUS ROAD SURFACES

Road surface	Wear index number	Annual cost of tire operation per 100 vehicles per mile per day	Tire operation cost capitalized at five per cent
Concrete	1 00	$200	$4,000
Monolithic brick	1 00	200	4,000
Bituminous filled brick	1 00	200	4,000
Iowa gravel	2 20	440	8,800
Chert gravel	7 30	1,460	29,200
Bituminous macadam (unsealed)	10 60	2,120	42,400

In considering the foregoing it should be noted that in the test runs the conditions, such as alignment of wheels and tires, were for the most part carefully controlled. Full standard inflation was used. The speed of twenty-five miles per hour is now probably too low to be considered as average The tires were probably above average in quality and received more than ordinary care. None but dry pavements were used. Considering all such conditions it seems certain that the above figures are conservative

Laboratory investigations are in progress to collect data upon the effect of inflation, temperature, moisture and tread rubber quality upon tread wear While progress has been made in all these phases of the investigation it is not now possible to state even preliminary conclusions

Investigations to be undertaken include the effect of speed, size and weight of vehicle upon tread wear, also roughness of road surface. The question of the relative wear of low, medium or high grade tires as affecting tire economy is an important one Statistics are needed showing the numbers of tires used in various size and quality groups.

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INVESTIGATION OF TIRE WEAR

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The Engineering Experiment Station of the State College of Washington has been conducting a series of measurements of tread rubber loss from automobile tires that were operated on some of the standard roads in the vicinity of Pullman, Washington Four different cars and four sets of tires were used so it is not possible to compare runs made with one car with those made with another The following preliminary report of the results is not considered to be conclusive, but is indicative of the general trend and should be evaluated on that basis.