THE INFLUENCE OF DIFFERENT ASPECTS ON TIRE WEAR

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ABSTRACT

A current method is presented to analyze the wear in the tire. The procedure includes 30 to 100 vehicles fitted with the target tires for wear. The amount of vehicle usage is taken into account. Full tracking of vehicles is done for all seasons with varied severity of usage. The tread wear is measured and comparison is drawn between radial and normal tires. It is found that duration of tire's life mainly depend on the amount of material removed. The method takes into account road surface, driving styles, routes, load, inflation and contact pressure. Tire wear is measured in the form of amount of material removed from tread. Results are presented in the form of statistical distribution. Results indicate that this method is more accurate in estimation of tire wear.

***Keywords**: Tire, wear, radial, normal, material removed.*

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INTRODUCTION

The wear performance of a tire is its capability to reach high mileages. One method of evaluating this wear performance is by considering the duration of

tire service life, which is the mileage after which a point on the tread appeared which shows signs of the wear. The duration of a tire's Service life depends on the mass loss from the tread, which is usually expressed in g/100km. The duration of a tire's service life depends on the various conditions in which the tire is used and that are the type of driver and their area of working.

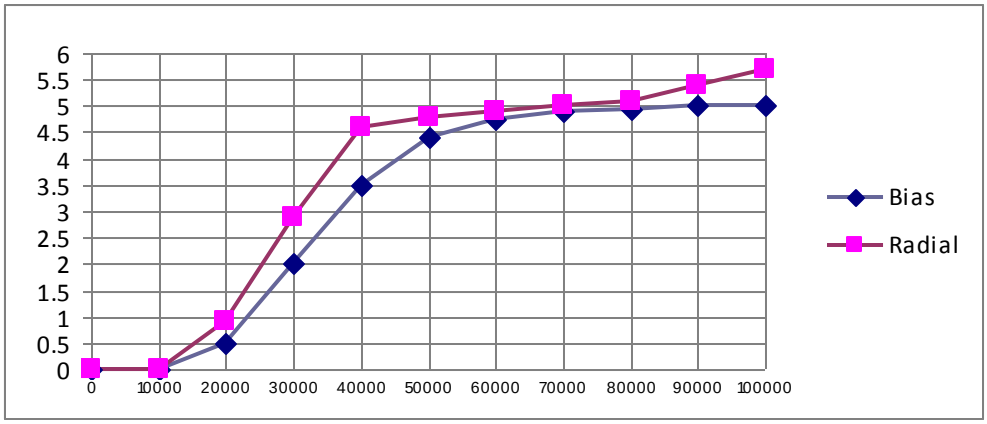

Figure 1: Mileage distribution

WEAR PARAMETERS

Wear dependents upon many parameters which take effect through a modification of the forces applied to the tire or through a change of the rubber/ground interface.

ROUTES AND STYLES OF DRIVING

The acceleration levels reached by the vehicle may vary .depending upon the route and the style of driving, These acceleration levels modify the forces applied to the tire. The system of loads causing wear in the contact patch (sliding, stresses) is directly proportional to these forces. The effect of the style of driving can be measured by measuring the tire wear on the same vehicle driven by different drivers over the same course. The variation in wear rates (in g/100km) is very significant. It can be understood by the differences in acceleration levels acted on by each driver. Relevant wear differences can be seen between the vehicles driven by regular drivers and the vehicles driven by moderate use drivers. This comes from the fact that a regular driver will drive the vehicle at the speed limit with universal acceleration levels much higher than those of moderate drivers. The effect of the course taken, independent of the road surface material, leads to differences, between a highway type path (0.5g/100km) and a very dusty path (8g/100km). These wear differences are also caused by variations in

the vehicle accelerations. It must also be emphasized that two different cases such as urban use (which enhances longitudinal accelerations) and a moderately dusting or rural road course, may lead to the same wear levels (3g/100km).

Table 1. Driver influence on wear

	Professional			Customer	
Driver	1	2	3	4	5
V Km/h	72.6	72.7	58.8	63.1	57.4
Wear (Bias)	28.5	19.0	8.8	7.6	4.6
Wear (Radial)	18.3	14.7	6.3	5.4	3.4

ROAD SURFACE

The ground has deep effect on wear and it impinges on wear through a modification of the rubber/ground interface properties (friction, abrasion). The road abrasion is highly dependent upon the micro roughness (but is roughly independent of macro-roughness) of the ground materials.

WEATHER CONDITION

Environmental conditions such as temperature and humidity are very weather-dependent. These conditions have a very much influence on the rubber/ground interface properties and therefore on wear. Figure indicates that tire mass loss (in g/100km) may vary between summer and winter or within the same weather, depending upon humidity and amount of water present in the atmosphere. The amplitude of these variations is linked to the rubber compound chemical formula, hence the requirement to characterize the tires on an annual basis in order to make a relevant , evaluation of the tread compound wear performance taking into account seasonal variations.

Table 2. Weather effects

weather effect (similar use)			
Rear wheel drive vehicle		Tread compound A – Bias	
Wear on rear wheel (g/100 km)		Tread compound B - Radial	
Summer	Autumn	Winter	
6.37 (5.92)	8.85 (7.92)	10.9 (9.42)	Dry
	5.06 (5.78)	7.13(7.66)	wet

THE VEHICLE

The various vehicle parameters such as Steering angles play important role in tire wear The average life of a tire may vary within a range of 50% or more depending on the vehicle characteristics. The vehicle characteristics of the greatest influence are weight, suspension

and Steering geometry. The alignment problems are often blamed for all irregular tire wear. However many other factors can be responsible for or contribute to irregular wear. Radial tires have a different footprint shape than bias tires. These results in less scrubbing and longer tread life. However, this same attribute of the radial design can also result in the tire exhibiting more irregular wear. Figure shows different footprint of bias and redial tires.

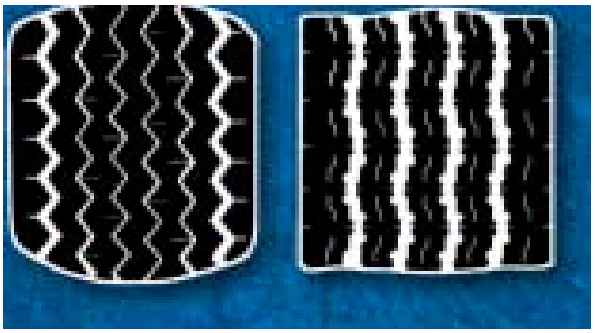

Figure2. A bias tire footprint is oval shaped…the radial footprint is rectangular

The tire is the link between the vehicle and the ground and therefore has a major effect on wear. The most important tire parameters acting on wear are the following:

- The different stiffness which determine the shape, stress and slip in the contact patch.
- The rubber volume available for wear.
- The material characteristics of the tread such as friction and abrasion.

Hence, the fact that tire size choice and inflation pressure are first order parameters for the wear performance of the tire. For example, a switch from a 165/70 R 14 to a 175/70 R 14 on the same vehicle leads to a 20% increase in the tire's life. This difference is due to the variation in rubber volume and stiffness's between the two tires. The inflation pressure of the tires also has a great influence on wear and worn profile. It acts on the shape of the contact patch and on the tire's stiffness's.

INFLATION PRESSURE AND TIRE LOAD

The effect of inflation pressure and load on the tire deflection is shown in figure which shows the stiffness of the carcass of the tires.

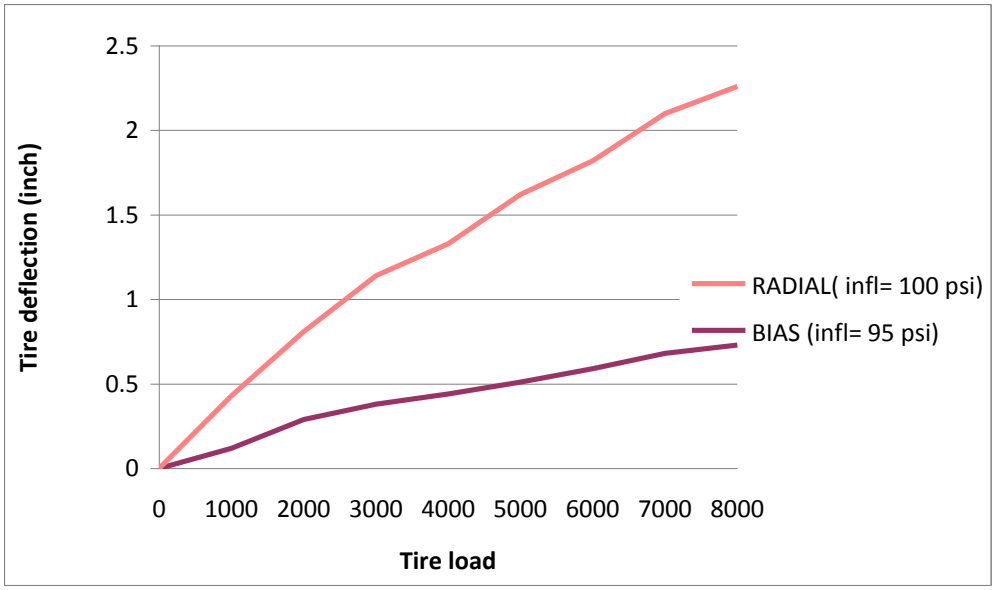

Figure 3. Load effect on deflection

A similar test was conducted to determine how the two tire types responded to load variation. Tire inflation was held constant at their rated T&RA conditions; this did result in a 20 psi difference between the two tires. Load was varied approximately +/-2,000 pounds, to simulate empty, fully-loaded, and over-loaded conditions. Both tires exhibited an increase in average contact pressure with increased tire load.

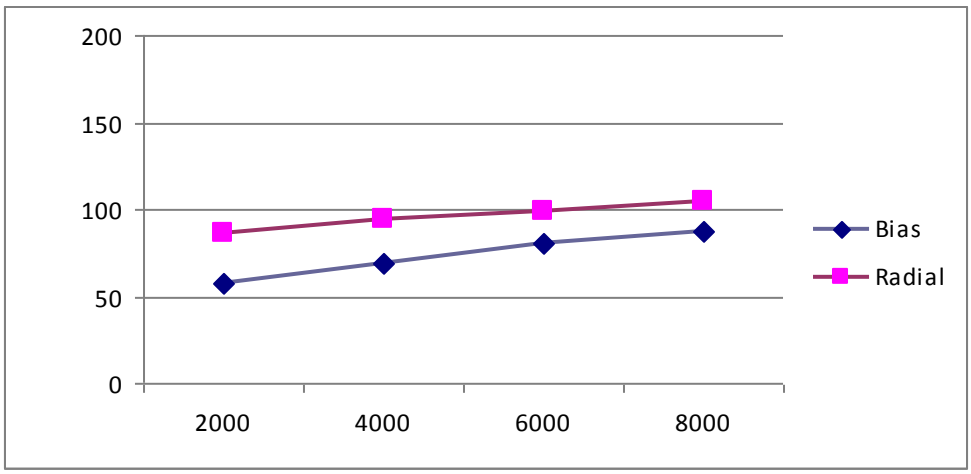

Figure 4. Load and contact pressure

PRESSURE DISTRIBUTION IN CUSTOMER USE

Pressure varies greatly in actual customer use (see figure), The tire manufacturer must take this fact into account when developing tires so that wear performance in a wide range of pressures is guaranteed. Depending upon numerous external and internal parameters, wear is a difficult performance to evaluate and this evaluation must be conducted in compliance with the various conditions the encounters in actual customer use. The only way to muster such a

diversity of use is to perform a statistical analysis in customer use and to regularly measure the tread wear throughout the year in order to average out the seasonal effect.

WEAR EVALUATION IN CUSTOMER USE

To evaluate wear performance in customer use, both a representative sample of customers (using a desired tire and vehicle) and a reliable method to analyze the results are required.

SAMPLE SELECTION

A sample is characterized by the following parameters:

- Type of vehicles;
- Areas in which vehicle is in service;
- Number of vehicles;
- Driving habits and styles;

VEHICLE TYPE

The choice of vehicles depends on the size of the tire to be tested. In every case, we choose vehicles which are new enough to avoid the effects of age on their inherent characteristics. The dispersion of vehicle's static settings, toe and camber, can also be criteria of choice. All the vehicles in the sample are selected with the same rim width.

NUMBER OF VEHICLES

Although we select the drivers at random for a given type of vehicle in a specific region, we need at least 100 vehicles to have a stable sample with a 5 % margin of error. With a sample of 200 vehicles, we reduce this error to 3.5 %.

DRIVING HABITS

The severity of use is estimated from accelerations of the vehicle or simply from the rate of mass loss from the tire (g1100 km). Its evolution is given by a statistical distribution. If we want to equip less than 100 vehicles, we need to know the severity distribution of the population. To do this we have to define different classes of severity. 'This enables us to survey only one given class of severity. Making classes or any boundary means making artificial quotas between customers. On the lognormal distribution, there is no point with special statistical signification to help define a boundary. We must, therefore, create a boundary which separates customers in terms of member numbers. The boundaries are made at the inflection points on the distribution curve and we add another separation point at the mean value in order to equalize the classes from both sides.

Table 3. Vehicle sample size

USAGE	VEHICLES
SEVERE	10
FAST	12
MODERATE	18
MILD	10

Vehicles used professionally, such as autos and ambulances etc, are always treated in a special way and must not be mixed with conventional vehicle samples. We find that driving habits of an individual tend to change very slowly during his/her life and does not depend on the type of vehicle driven at a particular time.

ANALYSIS METHOD

The method used to analyze the tread life is based upon the following steps:

- Vehicle and tire measurements
- Tread wear life calculation and statistical analysis.
- Comparison of results

VEHICLE AND TIRE MEASUREMENT

Tire analysis is to be always done on through out the annual cycle in order to eliminate any seasonal effect. The main vehicle characteristics to measure are the static settings (toe and camber) at the beginning and at the end of the test. Tire tread depth are individually measured at the beginning of the test, after 4 months, 8 months and 12 months, on at least five diametrically opposed angle positions and on 5 points across the tread (depending on the tread pattern). Inflation pressure is recorded (but not adjusted) at each tread depth measurement.

TREAD WEAR LIFE CALCULATION AND STATISTICAL ANALYSIS

Tread life is computed for each individual tire on the most worn points of the tread pattern. Statistical analysis and comparison of wear data are made and comparison is done for bias and radial tires. Results of tread life are plotted using a distribution. The most significant points of the data are shown in table 4 taken by the figure 1.

RESULTS

Evaluation of different tires is accomplished by comparing the values of tire mileage at various severity levels. for Bias and Radial tires. Rib tire are also taken into consideration and

found that must be properly loaded. Because of the notion that load being carried by rear wheel, front wheel are not loaded properly lead to most uneven wear pattern in front rib tires.

Table 4. Severity usage and its mileage in Km

Tire	severe	medium	mild
Bias	20000	33000	53000
Radial	31000	54000	83000

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