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Are New Tyres Faster Than Old Tyres?

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Abstract

The lowest legal depth of a tyre's tread is 1.6 millimetres. When thinking about a worn tyre with the legal tread limit the circumference is 0.034 metres less than a brand new tyre. Over the distance of which a car with new tyres travels at 30 miles per hour this difference in circumference equates to the car travelling approximately 0.511 miles per hour slower.

Introduction

Motor vehicle tyres come in all shapes and sizes based on the type of vehicle being driven and how large the rims are. Each tyre has a tread which increases grip by channelling water in to the tread pattern, allowing rubber to touch tarmac, avoiding aquaplaning. Over a period of time this tread will unquestionably wear down. The legally safe minimum depth of the tread is 1.6 mm continuously throughout a band in the central 3/4 of the width around the entire circumference of the tyre [1]. If the car goes below this, the driver is liable to 3 penalty points on their licence and a £ 2500 fine [2]. Most manufacturers recommend changing the tyres when the tread gets to a depth of around 3mm with some suggesting as low as 2mm [3]. This is 4.4 – 6.4 mm less radius of a brand new tyre with the original depth of the tread to be between 6 – 8 mm on most hatchback tyres. The way in which the tyre is worn depends on the speed at which the driver takes corners, the way they break and sometimes varies depending on suspension issues and underinflated or overinflated tyres.

This paper will look into the effects of running a car at the minimally legal tread depth and how many extra rotations the tyre would undergo and how this affects the speed of the car.

The Tyre

The tyre this paper will model would be inscribed along the wall with the following; “255/35 R 18 94 V”. This paper is interested in the first three numbers in this code. Firstly, 255 is the tyre width in

millimetres. Secondly, 35 is the ratio of the tyre's width to the tyre's height. This tyre has an aspect ratio of 35%. Lastly, 18 is the diameter of the rim in inches.

Calculations

The diameter of the tyre is key because speedometers, traction control, torque and gears are dependent on how far the tyre travels in one revolution [4]. To work out the total diameter of the wheel the tyre's width needs to be multiplied by the aspect height, ($255\text{mm} \times 0.35 = 89.25\text{ mm}$ (4 s.f.)). The aspect height is then doubled for the top and bottom part of the tyre, ($89.25\text{ mm} \times 2 = 178.5\text{ mm}$ (4 s.f.)). The radius of the rim is then converted to mm with the conversion of 1 inch to 25.4 mm, ($18\text{ in} \times 25.4\text{ mm} = 457.2\text{ mm}$ (4 s.f.)). By addition of the doubled aspect height and rim diameter we get the overall diameter of the tyre to be, ($178.5\text{ mm} + 457.2\text{ mm} = 635.7\text{ mm}$ (4 s.f.)) which in meters is 0.6357 m (4 s.f.).

Secondly the circumference of the wheel must be found which is done by multiplying the diameter by pi, ($\pi \times 0.6357\text{ m} = 1.9971\text{ m}$ (5 s.f.)).

If this circumference is to be altered for a worn tyre, assuming the depth on this gauge tyre to be 7 mm to begin with, using the same calculation as before but subtracting 10.8 mm from the overall diameter we get the circumference to be 1.9631 m (5 s.f.). This gives a difference in 0.034 m in circumference between a worn and new tyre.

If the car is assumed to be travelling at a constant speed of 30 miles per hour it will have travelled 48280.32 metres in one hour. A brand new wheel will have rotated a total of 24175.2 times. A tyre worn down to the legal limit will have rotated 24593.9 times. Therefore, the worn tyre will have to rotate an extra 418.7 times.

To calculate how much less distance a car with worn tyres travels undergoing the same number of revolutions as a new tyre, the number of revolutions is multiplied by the worn tyres circumference and gives, $(24175.2 \times 1.9631 = 47458.3 \text{ m (6 s.f.)})$. This therefore equates to a car with worn tyres undergoing the same number of revolutions to travel 822.0 m less. If we assume that these revolutions took the same period of time, one hour, to complete then the car was going 822 meters per hour slower or 0.511 miles per hour slower.

This means that there is a 1.7% difference in speed between an old and new set of tyres, when the

speedometer would indicate the same velocity. This is actually rather significant fraction; speed cameras tend to give around a 10% fraction over the speed limit before they will flash or 10% +2 mph for 30 mph or greater speed limit zones [5]. This is nearly one fifth of that tolerance.

Conclusion

Compared to a new tyre, a tyre worn down to the legal limit of 1.6 mm will cause the car to travel 0.511 mph slower. This change in speed will not be accounted for by the speedometer as the speedometer works by calculating the number of rotations being undertaken.

This difference in speed is not very dramatic but when thinking about stopping distances there is a great cause for concern when reaching the legal tyre tread limit because it can take the car up to 33 meters more to stop whilst travelling at 50 mph when considering changing the tyre at 1.6 mm or 3 mm.

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