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The Role Of Tire In Car Crash, Its Causes, And Prevention

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Abstract-- This paper looked at the role that tires play in car crash. In the course of our study, we analyzed various causes of tire related car crash which includes; tire pressure (under-inflation and over-inflation) and abnormal wears. Bad inflation pressure of tires, either under-inflation or over-inflation causes tires to wear easily and increases poor vehicle handling by drivers. The solution to the crashes originating from tire was also outlined; inflating the tire with its recommended inflation, using good tires that are not up to six years from the date of manufacture and also the use of tires with good tread will prevent tire related car crash.

Keywords--- Tire, car crash, inflation, prevention, wear, thread.

I. INTRODUCTION

Road accidents continue to be a major reason of deaths and permanent disabilities in our country. Tire being the only contact between the car and the ground becomes an area of concern, but unfortunately drivers and car owners do not care for the tire of their vehicle as they care for the car engine, radiator system etc. Most people do not fully appreciate the important role good and suitable tires play to the safe operation of their cars [8]. In spite of all the high-tech electronics controlling a vehicles handling capabilities and stability, its four tires provide the contact points on a roadways surface that ultimately control the amount of slipping and sliding that can take place [9]. Accidents originating from tires may be because of pressure or wear. Maintaining correct inflation pressure in tires helps to keep vehicle handling and braking at its best, as well as improving fuel efficiency and tire life [10]. It also prevents such events as separations and tire blow-outs which may cause loss of control of a vehicle and crashes. Tires are specified by the vehicle manufacturer with a recommended inflation pressure, which permits safe operation within the specified load rating and vehicle loading [11]. Wear in tires also contribute to these accidents. Tires play so many roles in the safety of a car; it can prevent an accident and at the same time can cause accident.

II. THE ROLE OF TIRE IN CAR ACCIDENT

Tires can play a large role in auto accidents if they are defective or worn.

Worn tires skid on wet roadways more than newer ones, increasing the risk of a blow-out, which could lead to a serious car accident. Other factors that come into play are the cases of warmer temperatures and the amount of pressure on a tire being more than the inflation pressure in the tire, putting drivers at serious risk of danger from a blow-out. The causes of the tire defects will be discussed under the following:

- Structural damage and
- Road performance of tire

A. Structural damage:

The effect which can well be deemed the most prevalent cause of an accident, resulting from the driver's loss of control over the vehicle. Structural damage of tires can be caused by the following:

I) *Under-inflation/overloading*: The biggest single cause of burst tires. Under-inflation causes excessive flexing of the tire sidewall which leads to overheating and ultimately, causing break-up and tread separation. Reduced tire-road contact leads to poor handling and faster wear [1].

II) *Vehicle maximum load*: The vehicle maximum load for your tire is critical and is set out by the vehicle manufacturer on the vehicle placard affixed to the vehicle. The vehicle maximum load should not be greater than the tires maximum load which is molded on the sidewall of the tire. The maximum load carrying capacity of your tire assumes the tire is operating at the proper tire inflation pressure. Reduction in tire inflation pressure will reduce the maximum load carrying capacity of the tire.

III) *Tire age/ageing behavior*: there are some evidences to suggest that aged tires have an increased likelihood of failure due to exposure to the environment. Ideally tires should be kept in a cool, dry environment out of direct sunlight. All tires have serial identification number, used to telling/identifying the age of your tire. For tires manufactured after the year 1999, the last four numbers identify the date of manufacture of the tire to the nearest week. The first two of these four numbers identify the week of manufacture (which range from "01 to 52"). The last two numbers identify the year of manufacture (e.g. a tire with the information (4809) was manufactured in the 48th week of 2009).



Figure 1. Diagram of a tire showing the manufactured date

Tires that are more than six years from the day of manufacture, should not be used again cause of ageing even if the tire has not been used initially.

Ageing behavior

- Sidewall cracking due to environmental exposure to oxygen, heat and sunlight.
- Tread cracking due to environmental exposure to oxygen, heat and sunlight.
- Hardening of the outside surface caused by oxidation of the polymers under influence of sunlight.

IV) *Incorrect load/speed indices*: illegal use of the wrong tires with insufficient load or speed indices has to be considered. The load capacity of a tire determines what payload each tire can carry [2]. All tires have a code that tells the maximum load capacity of the tire [3]. Ignorance of this has been the major cause of accidents originating from tire in Nigeria. Some passenger vehicles are now converted to cargo vehicle, in order to make extra cash, thereby endangering other road users. The tables below shows tire load index and its corresponding maximum load.

**TABLE 1
PASSENGER CAR TIRE LOAD RATING**

<i>Load index</i>	81	82	85	86	87	90	92	95	96
<i>Max. load/tire (kg)</i>	462	475	515	530	545	600	630	690	710

Speed indices show the speed rating of various tires, it tries to tell the driver the type of tire to use in the vehicle so as to match the speed of the car. It is not good to mix and match tires with different speed ratings on your vehicle. It is recommended that speed-rated tires be replaced in sets of four.

**TABLE 2.
TIRE SPEED RATING**

<i>Speed symbol</i>	<i>Maximum speed (km/h)</i>
N	140
P	150
Q	160
R	170
S	180
T	190
U	200
H	210
V	240
Z	240
W	270
Y	300

Note: The speeds are test speeds not recommended speeds.

It is advisable for drivers to match the speed of their tires with the top speed of their vehicle.

V) *External impacts*: in Nigeria, there are a lot of external impact that contribute to structural damage of tires, such as potholes, nails, debris, nails etc. This type of damage leads to slow loss of tire pressure.

VI) *Abnormal tire wear*: this can be caused by some factors like:

- Over-inflation of tire; causing the tire to wear at the middle of the tread.
- Under-inflation; causing the tire to wear prematurely at the edges of the tread.
- Poor wheel alignment; causing excessive wear of the innermost or outmost ribs.
- Incorrect toe-in setting; causing feathering of tire noticed when each tread rib develops a slightly rounded edge on a side and on the other a sharp edge.

B. Road performance of tire:

Despite being aware of existing differences in the performance of tires normally available in the market, it is very difficult to ascertain whether or not a tire is better; assuming that there was one available in a particular situation (for instance in an accident) that would have helped to prevent the accident under the given circumstances or would have at least reduced its severity [4]. The extent of how much inappropriate road performance of a tire contributes to the nature and extents of an accident can only be estimated. The tire's road performance can be influenced by various factors.

D) *Inflation pressure:* the performance of a vehicle is highly influenced by the tire inflation pressure. Contrary to popular belief, tire pressure is not determined by the type of tire or its size but upon your vehicle's load and speed [5]. Tires are specified by the vehicle manufacturer with a recommended inflation pressure, which permits safe operation within the specified load rating and vehicle loading. Most tires are stamped with a maximum pressure rating. For passenger vehicles and light trucks, the tires should be inflated to what the vehicle manufacturer recommends, which is usually located on a decal just inside the driver's door or in the vehicle owners hand book. Tires should not generally be inflated to the pressure on the sidewall; this is the maximum pressure, rather than the recommended pressure [6]. The principal effect of inflation pressure can be summarized as follows.

i. Optimum tire inflation pressure: proper inflation is the single most important factor in tire care. It maintains an even ground contact pressure of the tire and prevents uneven wear.

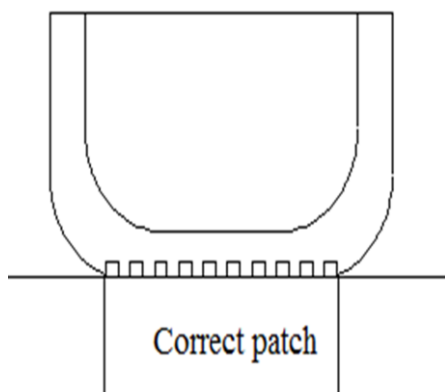


Fig. I: Correct inflation pressure

Internal heat are kept at constant level, because proper inflation pressure help discharge any heat that is generated and rolling resistance is also reduced. Optimum inflation pressure ensures maximum possible mileage, ideal patch, the optimum compromise of comfort, braking ability, cornering stability etc. [7]

ii. Over-inflation: higher inflated tires cannot isolate road irregularities well and this leads to harsher ride. Over inflated tires are more prone to damages when running over potholes or debris on the road. When a tire has too much air in it, the centre of the tread bears most of the load and wears out faster than the outside edges. If a tire wears unevenly, the useful life is reduced and conversely the operating cost is increased. Additionally stopping distances will be increased because less tread area is contacting the road surface.

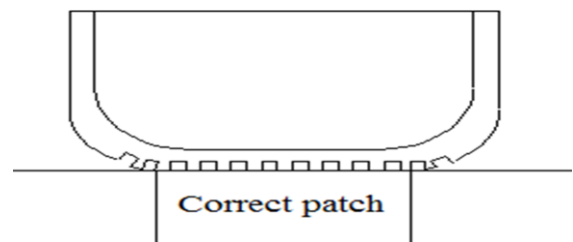


Fig. II: Over-inflation pressure

iii. Under-inflation: since the middle of the tire do not touch the ground, the tire rolls on the edge area and this leads to overheating of the tire caused by its increased flexion effort. It increases tire wear at the edges.

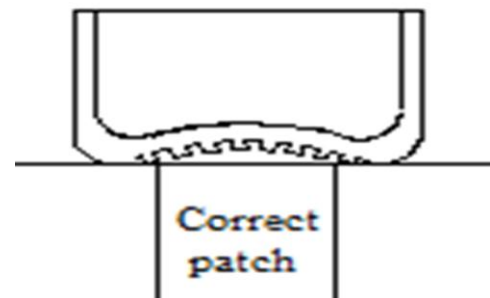


Fig. III: Under-inflation pressure

Effects of under-inflation

- Excessive heat leads to separation or cord failure.
- Greater rolling resistance lowers vehicle's fuel economy.
- Susceptible to standing wave deformation.
- Easier for tire beads to separate from wheel.
- Speeds up wear, in particular wear of shoulder parts.
- Excessive friction between wheel and tire beads can lead to bead failure.

III. HOW TO PREVENT CAR ACCIDENT ORIGINATING FROM TIRE

Accidents originating from tire can be prevented by the following ways:

- Proper wheel alignment of the vehicle to prevent/reduce wear of the tire.
- Tires should be properly inflated.
- Passenger vehicles should not be used to convey much load exceeding the recommended load of the tire by the manufacturer.
- Tires with different speed indices should not be mixed in a car.
- Tires up to six years from the date of manufacture should be changed, also spare tires that have not been used before but are up to six years should also be changed.

IV. CONCLUSION

Tires play a very important role in the safety of a car. As said earlier, since it's the only contact between the car and roadways, it should be cared for, if not more than any other parts of the car. The significance of the interaction between a tire and vehicle to which it is fitted has so far been underestimated. The type of wear in a tire can tell you, if the car needs wheel alignment, or if it needs toe-in alignment. Also the type of wear will tell show if the tire is normally inflated to the recommended inflation pressure.

Wears can be said to be normal, when the tread wears evenly across the entire surface of the tire. The edges and center sections of the tread wear down at approximately equal rates and no bumpy, directional or feathered wear patterns develop on the tread.

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