

IN DEEP TIRES DIAGNOSIS FOR A BETTER TRAFFIC SAFETY

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Abstract The main goal of this paper is to present an uncommon x-ray diagnose procedure for tires. The in deep diagnosis procedure can happen as results of incorrect mount/dismount techniques or as blowout accident.

The main responsibility for tire failures detectable from the statistics has to be attributed to the drivers/vehicle owners, resulting predominantly from failure to perform proper maintenance, i.e. operation in under-inflated mode, excessive tread wear and use of over-aged tires. There is an even higher ratio of accidents involving technical failures due to tires when adding accidents caused by a combination of human or accident-related factors and tires. to the evaluation.

1. INTRODUCTION

In order to give an idea of the extent to which the operating conditions of the tires are of essential importance for traffic safety, the followings provides an overview of tires operating factors, highlighting the effects and some of the specific hazards involved. In addition, the retread tires influences on traffic safety will be discussed in detail.

The effect which can well be deemed the most prevalent cause of an accident (besides excessive tread wear), of those which can be determined beyond a doubt, is the structural damage of a tire, normally resulting in the driver's loss of control over the vehicle. most probable, technical causes. In addition to the statistical figures on accidents caused by structurally damaged tires, a number of unknown cases of road users indirectly affected by such incidents can be assumed to exist.

2. UNDER-INFLATION/OVERLOADING TIRES OPERATING EFFECTS

In any case, deliberate or negligent abuse and failure to perform proper maintenance by the driver has to be regarded as a major reason for structural damage. This can either be by overloading the vehicle beyond the recommended and permissible limits (which is, in fact, not really an issue linked to the tire) or, truly disastrous if occurring simultaneously, under-inflation of the tire. Both cause the tire to overheat, followed by tread separation or burst and ultimately resulting in the driver losing control of the vehicle.

The influence of under-inflation on the tire's strength and durability, and resulting liability to sudden burst, can be described as follows [1]:

- 0.2 bar under-inflation causes a durability reduction of 10%;
- 0.4 bar under-inflation causes a durability reduction of 25% ;
- 0.6 bar under-inflation causes a durability reduction of 45%.

The examples above refer to continuous operation in under-inflated mode. It is important to note in this context that any operation (including over a relatively short period or distance) in under-inflated mode decreases the tire's overall durability, even if the tire is refilled again and constantly operated with the correct inflation thereafter.

As the tire has no contact with the road surface in the middle of the tread, it rolls strictly on the edge area.

Table 1. – Effects of under inflation tire. [1]

| Criterion | Effects of under-inflation | |
|---|----------------------------|--|
| Riding comfort | ↑ | A lowering by 0.5 bar results in a subjective assessment of 1 score better (scores from 1-10) |
| Grip on loose surface (sand) | ↑ | Approx. 3% more traction force when lowering inflation pressure from 2.5 to 1 bar, additionally 30% when lowering from 1 to 0,5 bar |
| Aquaplaning (water depth more than 2mm) | ↑ ↓ | Deterioration down to approx. 1.5 bar, then improvement by bell-formation of the tread towards the inside (at normal load) |
| Endurance (test rig) | ↓ | Lowering by 0.5 bar results in a deterioration of endurance test speed of 15 km/h |
| Tightness against external impacts (run over a kerb) | ↓ | Lowering by 0.5 bar causes a defect to occur at a speed of 20% lower |
| Bead unseating off the rim | ↓ | The threshold for bead unseating off the rim is between the recommended pressure and 1 to 1.2 bars. For safety reasons, this limit must never be under-cut |
| Tread wear | ↓ | A tire with 20% under-inflation reduces total mileage by 30% |
| Rolling resistance | ↓ | Lowering by 0.5 bar results in 15% higher rolling resistance force |
| Rolling noise | ↓ | A deviation of 1 bar to standard inflation pressure (~2.2 bar) raises noise emissions by 2 dB(A) (66%) |
| Wet grip | — | Effects not significant compared to the measuring tolerances |
| Vehicle handling on wet and dry surface | ? | With a medium-class saloon, a deviation of 0.2 bar on an axle can be noticed in changed vehicle handling and ride |
| Legend: ↑: improved performance →: unaffected performance ↓: deteriorating performance ?: variable performance | | |

This leads to severe heating of the tire, caused by its increased flexion effort. At worst, this can result in an unseating of the tire off the rim, which of course heightens the risk of an accident by a multiple. Operating in such abnormal mode negatively affects both mileage and durability of braking of an under-inflated tire. A deterioration of driving stability are to be expected, as the contact patch is reduced to a minimum and the required sidewall stiffness cannot be maintained anymore.

A further overview on the effects of under-inflation on the performance of a motor vehicle can be taken from the table 1, exemplarily displaying the effects of under-inflation on tire performance and durability. The numerical extent of the listed effects is not universally valid, though, but may differ from these tires.

2. OVER-INFLATION TIRES OPERATING EFFECTS

A significantly over-inflated tire contacts the road surface only in the middle of the tread, which results in increased wear at this location. This, in particular, reduces the mileage of the tire considerably. Due to the reduced grip area, the braking distance increases, and cornering stability is reduced. Additionally, the higher stiffness of the tire noticeably degrades riding comfort. In reality, over-inflation is the least probable abnormal condition, as it presupposes the unlikely case of deliberate misuse

3. SAFETY EFFECTS OF INCORRECT MAINTENANCE FOR TIRES

Tire waste and its disposal is a worldwide problem. Tires are not biodegradable; hence the time required for their decomposition is undetermined. Due to their chemical composition, tires, when burnt, release organic and inorganic pollutants to the air and soil, including hydrocarbons, dioxins, and other toxic substances. Tire disposal requires special and expensive technology, and ultimately the elimination of waste tires is not guaranteed. Many countries face additional problems dealing with tire waste, including lack of technical capacity.

Additionally, due to their shape and impermeability, disposed waste tires (including retreaded tires) can hold water for long periods, providing sites for mosquito larvae development. Thus, given that tires in developing countries are often disposed of in landfills and illegal dumps, tires become vectors for diseases such as elow fever, malaria, and dengue.

Used tires and tire material can often be recycled, for instance by tire retreading. Tire retreading, like other forms of tire recycling, postpones the eventual disposal of a tire.

Tire retreading contributes to a reduction in the total amount of tires used and disposed of over time, because retreading extends the life of the original tire by about 30%-100%.

While retreading is an environmentally friendly way of recycling a used product, trade in retreaded tires can increase the environmental and public health impacts of tire waste.

4. Experimental research

For tire failure analysis the US Maintenance Council recommends the following experimental operations [1]:

“Begin by inspecting the tread area. Look for punctures, cuts, foreign objects and any distortion in the tread. Move to the upper and lower sidewalls of the DOT side and then the non-DOT side of the tire. Inspect these areas for separation between casing components. This is usually denoted by cracks or bulges, damage to the bead and bead wires, deterioration of rubber caused by oil and grease, weather checking, cuts and penetrations. Then examine both sides of the interior looking for wrinkling or corrugations in the inner liner caused by running flat or underinflated, blisters or lumps, cracks and looseness. Mark all damage, punctures, and separations with a paint stick as you find them. Rotate the tire as necessary for thorough inspections. Use a probe to determine the origin and extent of damage. Inspect the complete tire prior to determining the cause of failure (i.e., often a separation in a tire sidewall may be caused by a nail hole puncture in

the tread or a failed repair that would only be noticed by inspecting the interior of the tire). It is possible for a tire to have more than one out – of - service condition. On the exterior of the tire, mark the final disposition based on your inspection for example, repair, retread, scrap, etc.”.

For experimental research of a tire with undercover/undiscovered faults, the authors has used a Bosello High Technology x-ray system from ICA Ghimbav, Brasov, Romania. For a better faults evaluation, we use also in research a new one tire from the same manufacturer and same specifications.

The tire claimed as having in deep failures is showed in fig. 1.

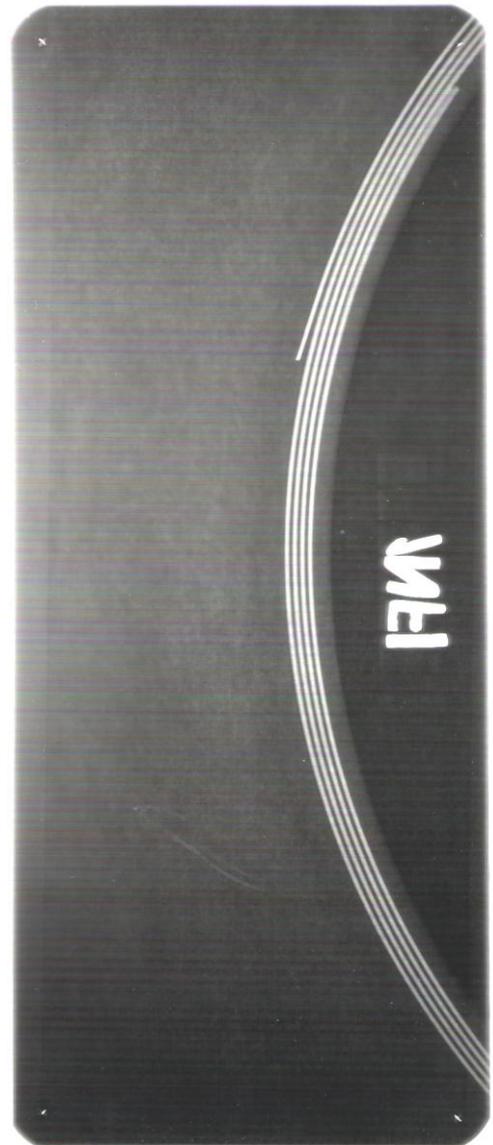


Fig. 1 The tire claimed as having undercover faults.

Fig. 2 X-ray figure inside tire with bead wire cracked.



Fig. 3 Bead wire inside into a new tire.



An uncommon diagnosis photographic technique was used for discover the real tire fault. The tire inside examined into x-ray photography was finding a bead wire cracked (see figure 2).

The bead wire of damaged tire was compared on bead wire of a new retreaded tire (same type and dimensions) made by the same manufacturer. The image of the new tire inside (also take in x-ray technique) can see in figure 3. For a good identification of fault source we examined also the tire correspondence hoop.

The cracked bead wire presents into involved tire can happen as results of incorrect mount/dismount techniques not at all as blowout accident.

4. CONCLUSION

1. In accidents involving technical failures tires have the largest or at least the second largest share in nearly all considered areas in Europe, Japan and the USA.
2. The main responsibility for tire failures detectable from the statistics has to be attributed to the drivers/vehicle owners, resulting predominantly from failure to perform

proper maintenance, i.e. operation in under-inflated mode, excessive tread wear and use of over-aged tires.

3. There is an even higher ratio of accidents involving technical failures due to tires when adding accidents caused by a combination of human or accident-related factors and tires. to the evaluation.

4. The existence of production-related failures is at least partly detectable in the statistics and therefore has to be considered to a certain extent with a view towards possible accident prevention.

5. The danger arising from operation in under-inflated mode, mostly caused by failure to perform proper maintenance, as well as from worn and over-aged tires, was already known before and is plausible, considering common technical sense.

6. The difficulties of getting more specific data are further confirmed by statements and the feedback from various parties engaged in intensive research of traffic accidents, be it the tire and vehicle industry themselves or independent institutions.

7. Admittedly, revealing the influence of the respective tire parameters is an extremely difficult and intricate task. This is mostly due to the complexity of traffic accidents, in which tires and related components or systems are often given merely secondary consideration (unless a failure or defect such as a burst or worn-out tire is obvious). For this reason, most accident reports lack the required details completely.

8. Even if reports contain information on the tires used as well as their condition, it is extremely difficult to determine the actual influence of the tire (were tires properly mounted, did they comply with permissible dimensions, load and speed index or tread depth, or not).

9. An uncommon forensic photographic technique was used for discover an undercover tire failure. The tire inside examined into x-ray photography was finding a bead wire cracked.

10. Analysis of involved tire were demonstrates that retreaded tire was not be to a traffic car accident origin.

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