ROAD HAZARDS: EXPLORING THE ROLE OF TIRES WHEN AN ACCIDENT OCCURS

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The roots of mobility in our modern day can be traced back to a series of inventions in the mid-1800s, which eventually led to the development of what we now recognize as tires. Tires are so widespread in use and application that the inherent complexity involved in their design and manufacturing is often taken for granted. Tires are a composite of rubber, metal, and fabric which play a key role in transportation as they are often the only part of a vehicle to actually touch the road. Because of this, examination of tires may be needed as part of a vehicle accident reconstruction, especially with respect to vehicle handling and stability when trying to determine causation. Unfortunately, the complexity that goes into the design and manufacturing of a tire can also make the evaluation of a tire in an accident reconstruction challenging. Thankfully, the tire itself tells a story, and an examination may give insight into whether tire performance influenced an accident.

Before discussing the possible role of tires in an accident reconstruction, the expected life and behavior of the tire need to be addressed. The rubber, metal, and fabric which comprise the tire are engineered to deliver a desired performance throughout the tire's life. A tire is designed in a manner where the end of the tire's life occurs because of a uniform loss of treadwear through normal use. A properly designed, manufactured, maintained, and operated tire will be either replaced or retreaded because of a uniform tread loss. A tire failure can, therefore, be defined as the tire being unable to perform its function, which ultimately leads to a loss of performance or early end of life of the tire. The challenge of the tire examiner with respect to accident reconstruction is to define if the tire failed in a manner that would have led to a loss of performance, which in turn influenced the resulting accident.

A tire failure is often typified as the tire no longer being able to maintain pressure. A loss of the ability to maintain pressure means the tire's performance has been compromised. The composite nature of the tire's construction unfortunately adds to the number of manners in which a tire might fail. Tires are complicated. The fact that tires contain dissimilar materials, and the individual materials comprising the tire have their own unique failure mechanisms means that examining the components of a failed tire both independently and in context with the other components may be required to answer the question of "what happened"? This also means that there are multiple different manners in which a tire could fail that must be eliminated through a systematic approach to examining the evidence.

To illustrate this point, think of a common fear when driving: the tire runs over a nail. In the simplest case, the nail penetrates through the tread, through whatever internal components are present in the construction (belts, plies, overlays, etc.), and through the inner liner of the tire. The inner liner of the tire is designed to keep the tire inflated, and the introduction of a breach now means a direct path for the internal pressure to reach the environment has occurred. This can cause an immediate development of a flat tire. From an examination perspective, the observation of a puncturing object, which can be tied directly to the loss of pressure in the tire and, therefore, a loss of performance, means there was nothing inherently wrong with the design, manufacturing, maintenance, or operation of the tire.

The presence of a puncturing object in the tire is not by itself enough to determine the cause of failure. As many tires continue to move, even after a loss of pressure has occurred (typically summarized as a run-flat condition), the possibility for the tire to pick up road debris after it has been compromised cannot be discounted. A breach that occurs after the tire has lost air pressure will have characteristics that are different from a breach that occurs while the tire is still under pressure.

Alternatively, a penetrating object that does not result in immediate loss of air pressure, such as the development of a slow or self-closing leak or a puncture that doesn't breach the inner liner, can develop localized separations that can grow over time. The depth of the penetrating object can also result in additional damage caused by the now-exposed internal components. While a localized separation may occur, chemical or environmental attack of the internal components has now been given a free path. This can result in early degradation of the rubber components due to ozonation or even rust formation on steel cords due to water accessing the penetration.

In the case described above, a noticeable penetrating or puncturing object was observed. Another type of foreign object damage is associated with impact. For a tire to sustain nonpenetrating impact damage, it needs to be inflated and impacted to the degree that the internal components are fractured or otherwise separated from the surrounding components. The steel belts or fabric plies in a tire are generally calendared with rubber in order to bind the dissimilar components together. When impacted, the steel or fabric can fracture and separate locally from the surrounding components. In other words, the cords in the tire can break without actually breaching the tire. The results of this scenario would be a growing separation and intra-carcass pressure. At this point, the tire hasn't technically failed as the internal pressure is still maintained, but the presence of bulges may become noticeable. Regardless, the internal components are now loose and allowed to move internally in a manner for which they were not designed. This can lead to over deflection, accelerated fatigue damage, and other early failures in the tire.

Over deflection of the tire caused by external factors such as punctures or impact can result in accelerated fatigue damage. Two other common occurrences resulting in an over-deflected tire are operating the tire while underinflated (UI) or overloaded (OL). While over deflection is often tied to the installation and alignment of the tire on the vehicle, ultimately resulting in uneven treadwear, over deflection associated with UI and OL is a slightly different variation. Tires are designed and manufactured for a specified speed rating, inflation pressure, and load-carrying capacity. When operated outside of these conditions, over deflection can result. Continued over deflection over a period of time can result in the development and growth of separations internally, which, if given enough time without intervention, can result in belt and tread separations under an accelerated timeframe. These types of failures take time to form, and internal separations leading to breaches in the tire will often be accompanied by evidence of rubber abrasion, reversion, or "bluing," which is a form of heat damage. The presence or lack of abrasion-type damage in the tire can, therefore, be used to help identify the timeframe of when separations occurred.

The failures described here are only a few examples of the manners in which a tire could become compromised or fail. Tires are complex. When everything goes right, all of the components behave in unison to move a vehicle. When tires fail, it is up to the tire examiner to not just identify the type of separation that occurred but to see if the cause of failure can be identified. In the case of an accident, examination of the tire can give insight as to whether the tire played a role in the accident or simply went along for the ride.

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