12th International Conference "Organization and Traffic Safety Management in large cities", SPbOTSIC-2016, 28-30 September 2016, St. Petersburg, Russia

Accident Mechanism Modeling for Failure of Tires in Motion

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Abstract

This work proposes a method of calculation of the dynamics of a vehicle movement caused by its turn due to destruction of the front tire. Front tire destruction leads to the sharp slowdown of the car with simultaneous trajectory deviation from the original motion without turning of the driven wheels. The radius of the car movement trajectory depends on the magnitude of the deflection angle. Owing to the angle of deflection it is possible to calculate the radius of the vehicle motion trajectory. This makes it possible to determine not only the place of destruction of the wheel tires, but also the moment of danger for the movement of oncoming cars, departing of the cars from the point of impact, and based on this – materials for technical investigation of the traffic accident.

1. Main text

During investigations of road traffic accidents (RTA), one of the main factors for correct analysis of the mechanism of the past event and its individual elements, is to determine the dynamics of the vehicle motion at the time of the accident. These dynamics determine the driver's technical ability to prevent the accident, knowing them helps reconstructing mutual disposition of the elements, objects and participants of the event at the moment of danger to traffic [Ilarionov (1980), Ilarionov (1989), Evtiukov and Vasiliev (2006), Korukhov (1988)].

The current method of determining the vehicle dynamics is based on calculation of brake marks, and in their

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absence — on the assessment according to eyewitnesses. However, the assessment of the dynamics of the vehicle by the brake marks is not always adequate to the actual events, and doing in based on testimony of eyewitnesses is very approximate. A better method is to optimize determining the dynamics of vehicle movement associated with destruction of the front tire to obtain reliable data during the examination of road traffic accidents and objective recovery of events [Nemchinov (1985)].

1.1. Problem statement

As an example, let us consider a traffic accident in which a car moving in the left lane, due destruction of the front left wheel tire, turns sharply left and makes a collision in the oncoming traffic.

The following is required to define:
- angle of the vehicle deviation from the original direction, caused by braking with the front left wheel as a result of destruction of the tire;
- trajectory of movement of the car into the oncoming traffic;
- possible speed at the time of the destruction of the front left wheel tire;
- baseline data for determining the drivers' technical capabilities of avoiding the road traffic accident.

1.2. Solution method

To answer the raised questions, we draw a scheme of the forces acting on the vehicle during braking with the front left wheel as a result of destruction of the tire (Fig. 1).

Let us assume that the tire destruction happened instantaneously; at the time of the front left wheel tire destruction the driver took his foot off the accelerator pedal; the forces of rolling resistance, friction in the car transmission and wind resistance are neglected. Furthermore, the following should be noted: at the moment of the tire destruction, the car during the side decelerating simultaneously gets rotated due to contact of front left wheel tire and the road. In this case, the effect of the left front wheel suspension rigidity on the process is so insignificant that it can be ignored in the calculations.