Spanish Journal of Innovation and INTEGRITY
ISSN: 2792-8268
Volume: 18, May-2023
http://sjii.indexedresearch.org

Testing of a Truck Tire Man (4x2), (6x4), in the Operating Conditions of the Hot Climate of the Republic of Uzbekistan

Raxmanqulov Fyasix Xamzayevich, Ph.D
Candidate of technical sciences, associate professor, "Automobile and automobile industry", Tashkent State Transport University, Tashkent, Republic of Uzbekistan

Boliyev Mansur Tuygunovich
Assistant of the Department "Automobile and automobile industry", Tashkent State Transport University, Tashkent, Republic of Uzbekistan

Ashurov Ortiq Foziljonovich
Assistant of the Department "Automobile and automobile industry", Tashkent State Transport University, Tashkent, Republic of Uzbekistan

Abstract: *The issues of operation of automotive equipment in special conditions were studied in the works; however, these works do not contain practical recommendations on the use of specific types of automotive equipment in the operating conditions of the hot climate of the Republic of Uzbekistan.*

Keywords: *The task, there are the following types of steering; diagnostic blinds include the somersault of the steering wheel and the determination of the required force to twist it.*

The analysis of the available works on this subject [1,2] allows us to single out from the total set of operational properties a number of the most important parameters that are closely related to the accelerated failure of vehicle components and assemblies in special conditions of their operation. To reflect the real operating conditions and link to the actual indicators of the operational properties of trucks in the urban hot climate of the Republic of Uzbekistan, in particular the metropolis of Tashkent, tests were carried out on a MAN truck, where the main purpose of this study was to study the operation of a car tire when a MAN TGS truck was moving. 33.360, MAN TGS 33.400, wheel arrangement (6x4), for rectilinear and curvilinear motion, on paved roads. It is known that a change in ambient temperature conditions affects the operation of tires and their interaction with the supporting surface, which leads to a change in performance properties, increased tire wear and fuel consumption by a truck. All this as a whole indicates the importance and necessity of taking into account the influence of elevated temperatures of asphalt concrete pavement on the performance properties of a truck in order to ensure their greatest adaptability to specific operating conditions.

Let us analyze the operational properties of a truck associated with its movement and the process of interaction of an elastic wheel with a solid asphalt concrete surface, with their meters and indicators, the influence of design and operational factors on operational properties.

The conducted studies of the operational properties of MAN, KAMAZ trucks revealed that, given the road and transport conditions and elevated temperatures during operation in the urban conditions of Tashkent, the indicators of the operational properties of trucks do not fully describe the effect of elevated asphalt temperature on the parameters of traction and speed properties in particularly on car tire performance and fuel economy. Analyzing the presented photos of the failure of tires of various

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brands of a truck MAN TGS 33.360, MAN TGS 33.400, wheel arrangement (6x4), we can say that tires of various brands installed on the rear (a) and front wheels (b) have the same type of damage and fail out of order without using its resource. Therefore, the performance tests of the truck tire MAN TGS 33.360, MAN TGS 33.400 are relevant and require further research. Considering the presented diagram, it can be said that when an elastic wheel is rolling under the influence of torque and an increased temperature of the road surface, the elastic tire is deformed, if this condition is described, then due to the influence of elevated temperature, the elasticity of the tire increases and, under the influence of torque, the tire twists, which in In the contact patch of the tire with the road, slippage occurs and the diagram of the acting forces is solved taking into account the increased temperature of the asphalt concrete pavement and the magnitude of the supplied torque, while the rolling radius of the wheel decreases and the rolling resistance force increases, therefore, the loss of engine power increases.

When the wheel is rolling, the temperature in the contact zone gradually increases from its beginning and reaches a maximum at the exit from the contact, where the greatest slippage is observed. At the beginning of the contact zone, the temperature is equal to the temperature of the tread of the tire and the road in contact with air and blown by the wind. When the wheel rolls, the temperature in the tire contact zone rises due to the influence of elevated air and road temperatures, as well as due to the friction of the tread rubber on the road surface. In this case, the process of heating the tire covers the entire area of the contact zone and proceeds at much higher rates of tire heating in the contact patch of the tire with the road than when rolling under normal conditions. As a result, on dry surfaces, the temperature in the contact zone of the tire can reach over one hundred degrees. The higher the speed of the truck, the higher the temperature at the contact of the tire with the road. Studying the nature of damage to tires of various brands of trucks MAN TGS 33.360, MAN TGS 33.400, wheel formula (6x4), mounted on the rear (a) and front wheels (b), they have the same type of damage, which indicates that under the influence of high temperatures acting in the area of the contact patch and the magnitude of the supplied torque, the rubber is devulcanized from the tire cord [4,5,6], which leads to the delamination of the tire tread on both sides of the wheel, and failure without using its resource. For a complete study, it is necessary to additionally conduct full-scale tests of MAN TGS 33.360, MAN TGS 33.400 trucks, with a full load and optimal air pressure in tires, in real operating conditions.

General issues of the operation of automotive equipment in special conditions were studied, for example, in [2, 3], however, these works are mostly theoretical in nature, and they do not contain practical recommendations on the use of specific types of automotive equipment in certain operating conditions. The analysis of the available works on this subject [1,2] allows us to single out from the total set of operational properties a number of the most important parameters that are closely related to the accelerated failure of vehicle components and assemblies in special conditions of their operation. To reflect real operating conditions and link to actual indicators of the operational properties of trucks in the urban hot climate of the Republic of Uzbekistan, in particular the megalopolis of the city of Tashkent, tests were carried out on a MAN truck, where the main purpose of this study was to study the operation of a car tire when a MAN truck was moving in rectilinear and curvilinear motion, on roads hard coated.

Analyzing literary sources [1,2,3], these works did not consider the issue of the impact of elevated temperatures on the interaction of an elastic wheel with a solid support surface, therefore, we will consider the interaction of an elastic wheel of a MAN (6x4) truck with a solid support surface in urban hot climates when driving along the streets of the city of Tashkent.

So, the question of the magnitude and direction of the forces acting on the wheels of the driving and driven axles in certain external conditions is solved unambiguously, then the effect of lateral forces, the magnitude and direction of forces, the interaction of the elastic wheel with the solid supporting

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surface of the car (6x4), depend on the ratio a number of design and operational factors. It is known that a change in environmental temperature conditions affects the operation of tires and their interaction with the supporting surface, which leads to a change in performance properties and increased fuel consumption by a truck. All this as a whole indicates the importance and necessity of taking into account the influence of elevated temperatures of asphalt concrete pavement on the performance properties of a truck in order to ensure their greatest adaptability to specific operating conditions.

Let us analyze the operational properties of a truck associated with its movement and the process of interaction of an elastic wheel with a solid asphalt concrete surface, with their meters and indicators, the influence of design and operational factors on operational properties.

The conducted studies of the operational properties of MAN, KAMAZ trucks revealed that, given the road and transport conditions and elevated temperatures during operation in the urban conditions of Tashkent, the indicators of the operational properties of trucks do not fully describe the effect of elevated asphalt temperature on the parameters of traction and speed properties in particularly on car tire performance and fuel efficiency. In Fig.1, there are photographs of the failure of tires of various brands of a truck MAN TGS 33.360, MAN TGS 33.400, wheel arrangement (6x4).

Fig 1. Rear and front tires MAN TGS 33.360, MAN TGS 33.400

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Analyzing the presented photographs in Fig. 1, the failure of tires of various brands of a MAN TGS 33.360, MAN TGS 33.400 truck, wheel arrangement (6x4), we can say that tires of various brands installed on the rear (a) and front wheels (b) have the same type of damage and come out of building without using your resource. Therefore, the performance tests of the truck tire MAN TGS 33.360, MAN TGS 33.400 are relevant and require further research. To determine the causes of failure of the tires of a MAN TGS 33.360, MAN TGS 33.400 truck, we consider the rolling of a solid and deformable wheel on a solid road surface. In Fig. 2, there are diagrams of rolling (a) of a solid wheel on a solid supporting surface, diagram (b) rolling of an elastic wheel on a solid supporting surface, diagram (c) diagram of forces at the point of contact of the wheel with a solid supporting surface, diagram (d) diagram elementary normal reactions in the contact patch of an elastic wheel with a solid support surface.

Where:

P_z is the normal force coming to the wheel; R_z is the normal response to the acting force P_z; P_k is the force of rolling resistance; P_m - traction force on the driving wheels; M_{am} - summed torque; V_a is the speed of the wheel; ab is the value of the shift of the normal reaction R_z, under the action of elevated temperature and applied torque.

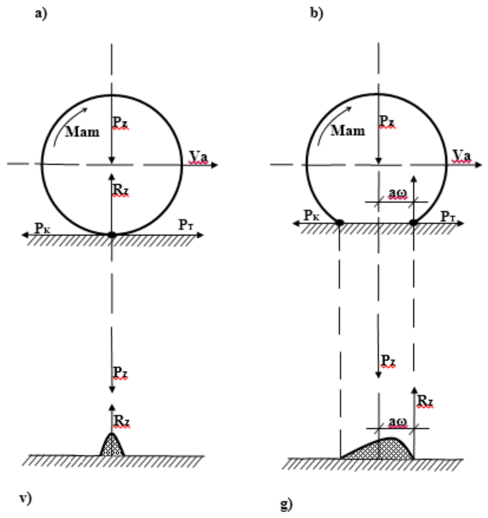

Fig. 2. Schemes of interaction of a wheel with a solid supporting surface.

\Analyzing the presented schemes, it can be said that when a solid wheel rolls on a solid supporting surface and the diagram of forces, the place of application of forces is the point of contact and is solved unambiguously. When rolling an elastic wheel under the influence of torque and elevated temperature of the road surface, deformation of the elastic tire occurs, if this condition is described, due to the influence of elevated temperature, the elasticity of the tire increases and under the influence of torque, the tire twists, which causes slippage in the contact patch of the tire with the road. and the diagram of the acting forces is solved taking into account the increased temperature of the asphalt concrete pavement and the magnitude of the supplied torque, while the rolling radius of the wheel decreases and the rolling resistance force increases, therefore, the loss of engine power increases.

To identify the causes of engine power losses associated with wheel rolling under the influence of high temperatures, we consider the features of rolling an elastic wheel on a non-deformable surface. The power loss that occurs when the wheel is rolling is measured by the rolling resistance coefficient f and elevated ambient temperature. Let us determine the value of the rolling resistance coefficient f according to the well-known formula proposed in the works of A.S. Litvinov:

$$f = a_{sh}/r_d + M_{am} \cdot (r_d - r_k)/R_z \cdot r_d \cdot r_k = f_c + f_k$$

Where: $f_c = a_{sh} / r_d$ is a component of the rolling resistance coefficient, which characterizes the power losses associated with the displacement of the normal reaction under the influence of tire deformation and high temperatures, causing a

moment directed in the opposite direction of the wheel rolling:

$$f_k = M_{am} \cdot (r_d - r_k)/(R_z \cdot r_d \cdot r_k)$$

Where: f_k is a component of the rolling resistance coefficient, which characterizes the kinematic losses associated with the transmission of torque (M_{am}), the rolling radius r_k (m) of the wheel decreases, as a result of this, a decrease in the speed of the car at a constant angular speed of the wheel; r_d is the dynamic radius of the wheel (m); R_z is the normal reaction of the road; a_ω is the displacement of the normal reaction of the road due to tire deformation in the initial part of the contact patch, in the direction of wheel movement. In this work by A.S. Litvinov [1], the operating conditions and the temperature regime of the tire were related to the central zone of Russia and were considered within about +20 degrees Celsius, and the operating conditions of the truck tire MAN (4x2), (6x4) were considered during operation in the Republic of Uzbekistan, which differ significantly, since the influence of elevated temperatures in a hot climate significantly changes the wheel rolling process and the interaction of an elastic wheel with a solid supporting surface at high temperatures exceeding +80 degrees Celsius. From literary sources [1,3,4,5,6,7], works (V.I. Knoroz "The work of a car tire"), it is known that the nature of the change in the friction force with an increase in the sliding speed of the tire depends on the thermal processes developing in the contact zone of coated automobile tires (expensive).

On Fig.2. Graphical dependences of rubber hardness on temperature in the zone of the tire contact patch with a solid supporting surface are presented, with various physical and mechanical properties of rubber.

Analyzing the presented graphical dependences in Fig. 2, we see that with a change in temperature, the physical and mechanical properties of rubber change, primarily hardness and elasticity. The elasticity of rubber also changes (Fig. 2), which increases with increasing temperature.

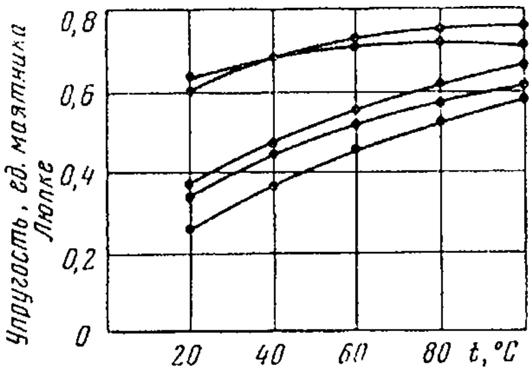

Fig.2. The dependence of the hardness of rubber (according to Brinell) on the temperature in the zone of the contact patch of the tire with a solid supporting surface, with different physical and mechanical properties of rubber.

The dependence of rubber hardness (according to Brinell) on temperature is well described by the equation of the following form:

$$HB = HB_o \cdot e^{a1}$$

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Where HB_0 — solidity, relevant 0°C; e– thermal conductivity of rubber; a — coefficient, dependent on material properties.

However, when the temperature rises to the level at which the transition of rubber from the vitrified to the highly elastic state occurs, its modulus of elasticity decreases by four orders of magnitude. The consequence of this is a significant change in the friction force in the contact patch of the tire, with an increase or decrease in temperature. Figure 3 shows a graphical dependence of the friction force of the tread rubber, with an increase or decrease in temperature in the zone of the contact patch of the tire with a solid supporting surface.

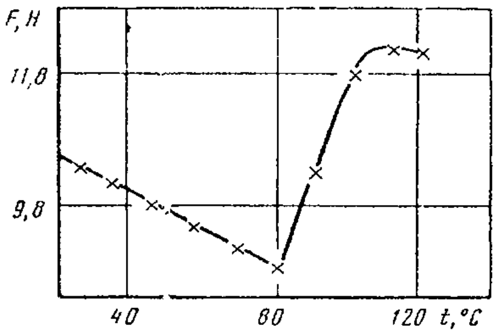

Fig. 3 Dependence of the friction force of the tread rubber in the contact patch of the tire, with an increase or decrease in temperature.

Analyzing the graphic dependence presented in Fig. 3., we can say that under the influence of high air temperature and the road, the torque supplied to the wheel, in the zone of the tire contact patch with the road in the initial stage, when the tire is heated, the rolling resistance decreases due to the increase in rubber elasticity , in the future, at temperatures exceeding 80 degrees Celsius, in the area of the contact patch of the tire with the road, there is a sharp increase in the rolling resistance force, which significantly increases the loss of engine power and fuel consumption by the car.

When the wheel is rolling, the temperature in the contact zone gradually increases from its beginning and reaches a maximum at the exit from the contact, where the greatest slippage is observed. At the beginning of the contact zone, the temperature is equal to the temperature of the tread of the tire and the road in contact with air and blown by the wind. When the wheel rolls, the temperature in the tire contact zone rises due to the influence of elevated air and road temperatures, as well as due to the friction of the tread rubber on the road surface. In this case, the process of heating the tire covers the entire area of the contact zone and proceeds at much higher rates of tire heating in the contact patch of the tire with the road than when rolling under normal conditions [11].

As a result, on dry surfaces, the temperature in the contact zone of the tire can reach over one hundred degrees. The higher the speed of the truck, the higher the temperature at the contact of the tire with the road. On Fig.4. a graphical dependence of the temperature of the asphalt concrete pavement on the ambient air temperature is presented.

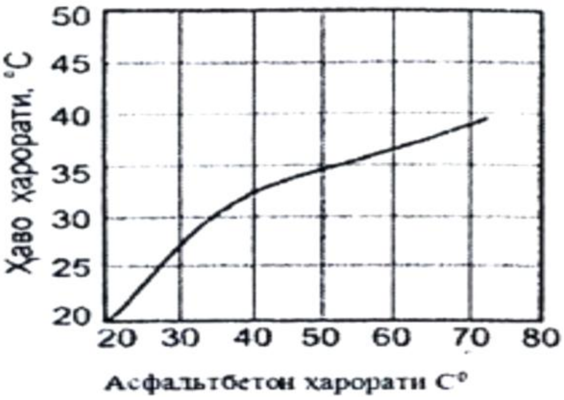

Fig.4. The dependence of the temperature of the asphalt concrete pavement on the ambient air temperature.

Analyzing the graphic dependence presented in Fig. 4., it can be said that under the influence of high ambient air temperature, the temperature of the asphalt concrete pavement increases non-linearly, at an air temperature of 400 C., the temperature of the asphalt concrete pavement of the road is more than 700 C. When a torque is applied to the wheel, in the area of the tire contact patch elevated temperatures occur with the road due to the friction of the tread rubber on the road surface, there is a significant heating of the tire in the contact patch area. During long-term high-speed driving of a truck, residual deformation and hysteresis losses in the tire lead to a sharp increase in the rolling resistance force, which significantly increases engine power loss and fuel consumption of a truck.

Studying the nature of damage to tires of various brands of trucks MAN TGS 33.360, MAN TGS 33.400, wheel arrangement (6x4), mounted on the rear (a) and front wheels (b), have the same type of damage, which indicates that under the influence of high temperatures operating in the area of the contact patch and the magnitude of the applied torque, the rubber devulcanizes from the tire cord [4,5,6], which leads to delamination of the tire tread on both sides of the wheel, and failure without using its resource [12].

The conducted studies of the operational properties of MAN, KAMAZ trucks revealed that, given the road and transport conditions and elevated temperatures during operation in the urban conditions of Tashkent, the indicators of the operational properties of trucks do not fully describe the effect of elevated asphalt temperature on the parameters of traction and speed properties in particularly on tire performance and fuel economy. For a complete study, it is necessary to additionally conduct full-scale tests of MAN TGS 33.360, MAN TGS 33.400 trucks, with a full load and optimal air pressure in tires, in real operating conditions [13].

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