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Current Problems With Car Tires For Fire and Rescue Equipment Operation

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Abstract: *The article analyzes the operation of tires of fire and rescue vehicles, tire wear from the impact of an aggressive road surface, influx of thermal shock, road class and climatic conditions. Recommendations are given for calculating the service life of tires for fire and rescue equipments.*
Keywords: *The surface of the road, pavement, cross profiles, carcass, fatigue wears out the tread*

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Introduction:

The road surface, types and conditions of the road surface, longitudinal and transverse profiles and road tortuosity affect tire wear. A large amount of road surface roughness and irregularities wears out the tread faster, fatigue of the carcass appears and the tire's resistance to mechanical damage decreases.

On highways, large and steep descents, ascents and turns most often create overload on the front, rear, right or left wheels. In this case, you have to accelerate and brake the car, and this increases friction and heat generation in the tires and accelerates their wear. Highways with convex cross sections cause a considerable overload of the tires on the right wheels, which are unloaded on the left, resulting in accelerated wear of the tires on the right side. When a vehicle drives in the middle of a narrow asphalt concrete road with a strongly convex cross-section, some overload occurs on the inner dual tires, increasing their wear.

Unlike other vehicles, the tires of fire and rescue vehicles wear and deteriorate differently. Thus, even while not in motion (on combat duty), fire-rescue vehicles are continuously under strain due to rapid temperature changes, hostile conditions (acid, alkaline, and other chemical hazardous compounds in flames), and the input of thermal shock during a fire and paved roadways.

The inclusion of a gravel stretch with a length of, say, 35% of the overall length on a category A road (see Table 1) increases tire wear rate by 30-70%. [1].

Highways of the "motorway" class have the following characteristics:

- a multi-lane roadway with a central dividing strip along its entire length;
- no intersections at the same level with roads, railways, tram tracks, bicycle and pedestrian paths;

- access is only possible through intersections at different levels, no more than 5 km apart.

Highways in the "highway" category include the following characteristics:

- a multi-lane roadway with a central dividing strip running the length of it;
- not having crossings at the same level with highways, trains, tram lines, cycling and pedestrian routes;
- accessable via intersections at various levels and junctions at the same level (without crossing direct flows), located no more than 3 km apart.

Highways designated as "regular type roads" are those that are not classed as "motorway" or "expressway" [2]:

- having a single carriageway or a separating strip in the middle;
- access to which is accessible via crossroads and junctions at different and same levels, positioned no more than 600 m apart for roads of categories IB, II, III, no more than 100 m apart for roads of category IV, and 50 m apart for roads of category V.

The road profile in hilly places, with steep ascents and descents and a high number of small-radius curves, has a considerable impact on tire wear. For example, increasing the specific gravity of a mountain profile along a road by 25% increases the wear rate of passenger car tires by 75-90%. The difference in wear between truck tires operated on steep and flat routes is substantially less - no more than 20%.

The excessive wear rate of passenger tire tread in mountain profile circumstances is explained by greater slippage of the tread mark in the tire's contact region with the road due to the occurrence of forces generating lateral wheel slip. The low wear rate of truck tires on mountain roads is attributable to their design characteristics and low vehicle speeds.

Climatic conditions have the greatest influence on tire wear: temperature and humidity of the surrounding air and the road. Thus, tire wear in winter on hard road surfaces is approximately 25-30% less than in summer

Main technical characteristics of classification characteristics of highways

table. 1

Road class	Road category	Total number of lanes	Lane width, m	Central dividing strip	Intersections with roads, bicycle paths and pedestrian paths	Intersections with railways and tram tracks	Access to the road from the junction at one level
Motorway	IA	4 or more	3,75	Mandatory [1]	At different levels	At different levels	Not allowed
Highway	IБ	4 or more	3,75				Allowed without crossing the direct direction
Regular road (low-speed road)	IB	4 or more	3,75		Intersections at the same level with traffic light regulation are allowed		
	II	4	3,5				Allowed
		2 or 3[3]	3,75	Not required	Intersections at the same level are allowed [4]		
	III	2	3,5				
	IV	2	3,0			Intersection at one level is allowed	
	V	1	4,5 and more				

1. For existing four-lane motor roads of category II, the absence of a dividing strip is allowed, but only on the condition that during major repairs or reconstruction a dividing strip will be provided. For new four-lane roads of category II, the absence of a dividing strip is not allowed (Resolution of the Government of the Russian Federation of September 28, 2009 No. 767 “On the classification of highways in the Russian Federation”).
2. More than six lanes are allowed only on existing roads.
3. Three lanes only for existing roads.
4. The intersection of a 4-lane road of category II with a similar one is carried out at different levels. Other options for the intersection of roads of category II with roads of categories II and III can be carried out either at different levels or at one level (subject to traffic light regulation, “assigned” left turns or a ring-type intersection)

When the ambient temperature rises, heat generation in the tires increases, and the tread wears down faster, lowering tire service life. Because of increased air dispersion through the chamber walls, a rise in ambient temperature produces a reduction in tire tightness.

When the temperature of working tires is decreased by a low ambient temperature, the total wear of the tires is reduced. Premature tire wear is likely in low-temperature situations owing to the rubber losing its flexibility and becoming brittle. [2].

When parking fire and rescue vehicles in the open or storing them without a garage in cold weather, do not put pads under the tires; they will harden and freeze to the ground, and moving the vehicle (especially abruptly) can cause tire material weakening and even tearing off tread from the tire carcass.

In addition to the foregoing, the tires of fire and rescue equipment are continually distorted while in operation. A fire-rescue vehicle ATs-40 (tank truck) with a combat crew, for example, has a gross weight of 9600 kg when loaded with water and equipped with fire-fighting equipment. The influence of load on such vehicles' tires has a substantial impact on tire life.

A automobile tire's components not only wear down due to friction on the road surface, but they are also subjected to the damaging effects of sunlight and chemical reagents. As a result, the tire undergoes general physical and chemical aging. And, if a tire's physical wear may be detected, the effects of changes in the rubber structure caused by harsh settings and situations are nearly difficult to assess.

Furthermore, the movement of a vehicle at a specific speed affects tire wear due to the action of driving forces and forces that oppose movement.

Rolling resistance forces Pf, resistance caused by road rise Pa, air resistance Pw, and resistance of inertial forces Pj are some of the factors that restrict automobile movement. The torque produced by engine activity is sent to the vehicle's driving wheels via the power transmission and axle shafts. The friction force that arises between the wheels and the road surface prevents them from rotating [1].

During rotation, the drive wheels generate circumferential forces that operate on the road, attempting to push it back. In turn, the road exerts an equivalent response (tangential reaction) on the wheels, causing tire degradation.

As a result, the solution to the problem of reducing car tire wear must be comprehensive, taking into account the condition of the roads, the materials used to make the tire, climatic conditions, the impact of the external environment, and the forces that impede the movement of the car.

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