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THE OPTION OF DECREASING COST BY ADVISABLE CARE OF TYRES

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1. Introduction

Actual vehicles have different types of an active and passive safety and also electric supporting devices, which help to decrease consumption of fuel. Due to them drivers in many cases think tyres are not important for their cars and they forget about the fact that tyres are the only part of the vehicle that touch with the road and their condition influences the function of the mentioned electric supporting devices. The one tyre of the car has interface from 200 to 500 cm^2 – Drivers neglect about their tyres. Survey of the firm for controlling the pressure in tyres approves it. They found out that approximately only 20% of drivers control the pressure in tyres and they ride on the right inflated tyres.

2. The ways of decreasing cost

Due to calculation of price, Tyres are treated as cost directly proportional to the travelled distance and we cannot change their price we spend on them, because lifetime of tyres is dependent on the travelled distance, using of them cause them to be "worn-out tyre" and if you break the law about their given wear-out you have to change them immediately. But the given statement is not always true. The features of the tyres influence the size of rolling resistance and in fact also the consumption of fuel, and because of moving forces between the tyre and the road influence the ability of the vehicle to handle the grade-up and they also influence the safety of driving resulting in the braking distance and keep the ability to control the vehicle. But these abilities don't influence the cost of operation directly. They will appear in a case of delaying vehicle on the road because in winter it couldn't handle road with higher grade-up. If the road accident appeared and the transported goods are damaged the tyres would influence the cost in the transport company.

We can divide the influence of tyres to cost of operation according to given considerations. Lifetime of tyres (next in 1000 units), based on measurements made by manufacturer of tyres Matador Púchov, which are given in the 1. Table. These results can be

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achieved only if we use them properly. The wrong inflation of the pressure, wrong sided axle, hazing of the vehicle, quality of the road and taking care of the car this distance make shorter. The distance of travelled KM can be increased also by using slitting of the depth of tyre profile at tyres with a name "REGROOWABLE".

Tab. 1: Lifetime of the tyres (1000 km units)

Type of traffic	Front (riadiaca)	Drive (záberová)	Trailer (vlečená)
Haulage	140 - 180	150 - 190	180 – 280
Regional	90 - 130	120 - 160	
Mixed	60 - 120	80 - 140	
City transport	80 - 140		

Source: www.matador.sk

In the figure 1. Is shown the care of driver of the tyre. The tyre is damaged because of it has a caught small rock or other foreign object between dual-tyres. The damage of the tyre is presented because the driver didn't control his tyres in the break-time. So the total damage occurred on the both dual-tyres. By this irresponsibility the driver caused not only the damage of the tyres, but also the fire could occur. The small rock between tyres could cause friction, which creates heat and the fire would inflame. The cars behind the "damaged car" can be also in danger, because the rock can be easily released by the centrifugal force. The energy of the freed rock is very high, when the release happens in higher speed (Nowadays the lorry can reach maximum of 90 $km.h^{-1}$). We have to take in consideration that the car behind has also high speed (in this case the same) and so the sum of the speeds is 180 $km.h^{1-}$. If the rock weighted from 0,5 to 1 kg it would have enough energy to cause great damage to the vehicle.

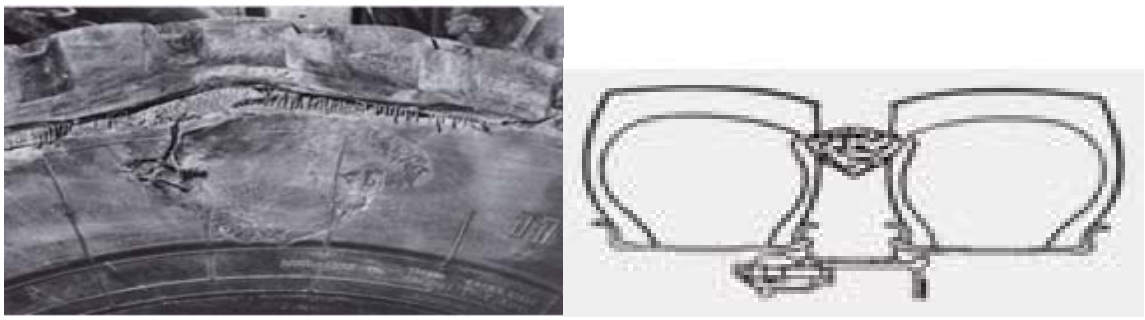

Fig. 1: Damage of the tyre caused by foreign object (firm literature Barum Continental s.r.o Otrokovice)

The lifetime of the tyres is also rapidly decreased by driving on underinflated tyre. In the figure 2. Is shown possible result of driving on underinflated tyre. It was due to higher

deformation so heated up that it caused the separation of the base. The same result as the ride on underinflated tyre has the drive on the overloaded tyre. This condition can occur not only in the overloaded tyre but also if one of the dual-tyres is underinflated or it has shorter radius than the other one. In that case the right inflated tyre has to handle more power (the wrong one will share the power with the good one in greater deformations). It means that the right tyre will behave as the underinflated one, so that the worse make the lifetime of both tyres shorter. As at the beginning was mentioned due to the survey there is only 20% of drivers who regularly control the pressure in their tyres.

Fig. 2: Damaged tyre caused by their underinflation (firm literature Barum Continental, s.r.o. Otrokovice)

Driving on the underinflated tyres makes shorter their lifetimes not because of their total destruction. On the wrong inflated tyre is cross deformation of slider occurred (fig 3.). As we can see only the part of the slider is bald, because that causes higher overload out edges interfacing area. With the overinflated tyres it is other way around, when the baldness starts in the middle of tyre profile. On the right inflated tyre is its slider bald equally. Wrong inflatation of the tyre has consequences not only on their shorter lifetime, but also on the transport of their tangent forces between road and tyre, because their transport consists of 3 parts. Friction between rubber of slider and road. Hysteresis of rubber of slider and abrasion of rubber of slider. Smaller interface area of tyre with the road means also less share hysteresis and abrasion. And so that less transported tangent forces. Tyre with its radial elasticity share the absorption of disparities of the road and it block their transportation on the transported people and goods. Overinflated tyre has higher radial consistence and so the disparities on the road transport on the hanging tyres. Overinflated tyre makes not only its lifetime shorter, but it does also higher depreciation on hanged tyres.

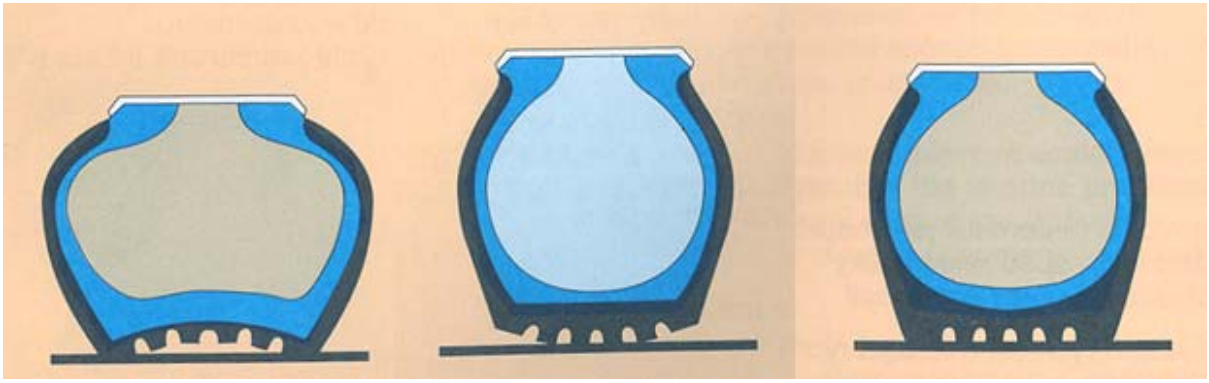

Fig. 3: The influence of underinflation, overinflation and the right inflation on the bald tyre (PETR CHVÁTAL: Autoškola CDE, Springer Media CZ s.r.o., ISBN 80-902549-7-7)

As the firm Matador Púchov says, there is possibility to predict shortening of lifetime of the tyres according to % measurement of underinflation due to Figure 4. From the given, we know that the shorter lifetime has unfavourable effect on the cost. Similar to wrong inflation of tyres, is the lifetime of tyres shorter by wrong set up geometric axle, and its consequences are shown on the figure 5. The edge of the tyre profile break the law, which confirms the minimum depth of the tyre profile and nevertheless the depth in the middle of the slider is adequate, tyre must be change for the new one. In this case the tyre will have shorter lifetime, so lower KM output as it was said in the table 1.

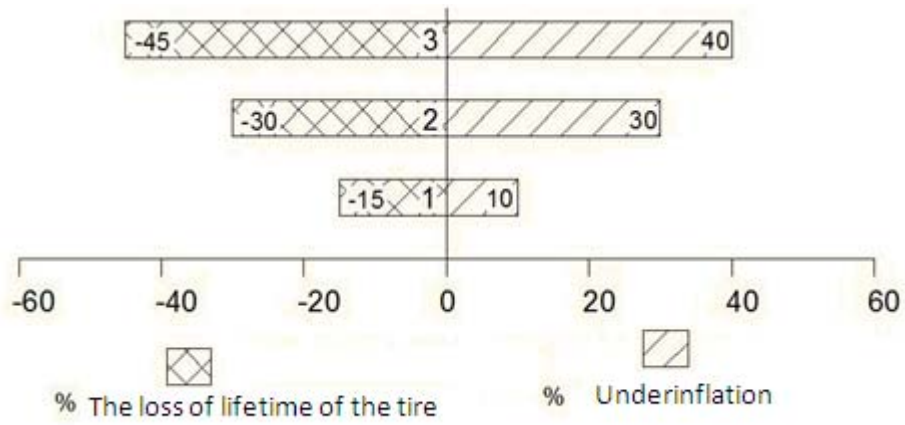

Fig 5: The los sof lifetime of the tire (Firm literature Barum Continental, s.r.o. Otrokovice)

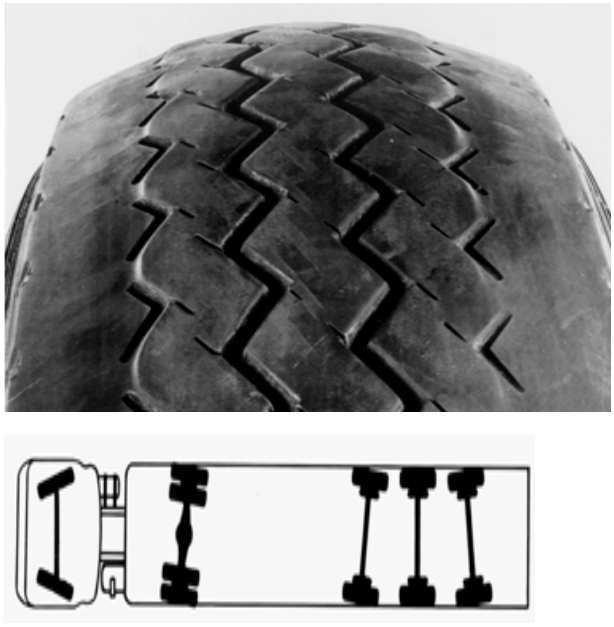

Fig 5: The los sof the lifetime due to wrong set up geometric axle (Firm literature Barum Continental, s.r.o. Otrokovice)

Tyre after its depreciation due to its legislative specified criteria doesn't belong to be rejected. If it has the body, which is not damaged and on its side is written REGROOWABLE, it is possible to make the tyre profile deeper and so to make longer its KM output up to 30%. Cost of making the depth of the tyre profile deeper is much more lower compared to longer lifetime. If making the depth of the tyre profile is done in a proper way, It is possible to protectorate this tyre and to save your money.

Tab. 2: The comparison of new and retreaded tires

The tire manufacturer	Dimension	Price in € without VAT	Costs of 10x pieces of tires in €	Possible saving
Continental	295/80 R 22,5	429,26	4 292,60	0
Protektor Continental	295/80 R 22,5	203,28	2032,8	2259,2
Matador	295/80 R 22,5	394,79	3947,9	0
Protektor Matador	295/80 R 22,5	141,34	1413,4	2534,5

Source: Continental, Pneubox, Matador

As it was mentioned, another option to extend tyre life and reduce the cost of them is retreading. If the vehicle is driven under severe conditions (according to Table 1 forests, mines, quarries, etc.). lifetime lasts for only approximately 20 000. Km. In some cases it means replacing the whole set of tire two times in a year. Retreaded tyres retain their properties over new. Advantage of such tyre replacement is evident from the data in Table 2,

where the prices of new and retreaded tires and comparison their prices between different manufacturers are also given.

At the beginning we said that tyres affect not only the amount of operating costs by recovering of tyres but also have a significant impact on fuel consumption. Recently, manufacturers offer tyres with lower rolling resistance and thus reduce consumption of fuel by reducing rolling resistance. Comparison of fuel consumption to overcome rolling resistance is show different speeds and is also shown for cars and trucks in Table 4. The Comparison was made for cars which basic parameters are listed in Table 3.

Tab. 3: The input parameters for calculation of fuel consumption

	Passenger car (PC)	Lorry
Frontal area [m^2]	2,1	10
Drag coefficient c_x	0,3	0,7
The mass of vehicle [kg]	1500	40 000
coefficient of rolling resistance f	0,012	0,007
Density of fuel [kg/dm^3]	0,76	0,84
Specific fuel consumption [g/kWh]	220	195

We used some simplifications in the calculations for example, coefficient of rolling resistance is considered to be constant, although it is well known that it changes with speed, temperature and other conditions. Also the specific fuel consumption calculation, we considered to be constant, although this varies with engine load and speed. While driving at a steady speed and in a straight path.

Tab. 4: Fuel consumption required to overcome rolling resistance and air

Speed [km.h^{-1}]		Air resistance		Rolling resistance	
		[kW]	[l/100 km]	[kW]	[l/100 km]
90	PC	6,38	2,05	4,41	1,42
	Lorry	70,88	18,28	68,67	17,71
80	PC	4,48	1,62	3,92	1,42
	Lorry	49,78	14,44	61,04	17,71
70	PC	3	1,24	3,43	1,42
	Lorry	33,35	11,06	53,41	17,71
60	PC	1,89	0,91	2,94	1,42
	Lorry	21	8,13	45,78	17,71
50	PC	1,09	0,63	2,45	1,42
	Lorry	12,15	5,64	38,15	17,71

Source Authors

Without ascent or descent to the driving resistance contributes more air resistance. For comparison of the size of the resistance, the size of each resistor is calculated in the table 4. According to the table, the air resistance is more important at speed of 80km/h, meanwhile, the rolling resistance was important, in other words-tyres.

The tyres affect fuel consumption through poor technical condition of the vehicle. Poor wheel alignment not only causes increased tyre wear, but also increase rolling resistance. For example, a bad toe front-wheel may increase fuel consumption by up to 5%. Cornering due to the decomposition of the tangential force also increases fuel consumption.

3. Conclusions

Through this paper we wanted to stress the importance of tyres with respect to their maintenance and costs associated with them. Aim was to familiarize the public with the issue whilst at the same time summing up certain possibilities how drivers can save up by the selection of suitable tyres and proper maintenance. Simplifications were used in the calculations.

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