



PROBLEM OF THE SELECTION OF THE RATE OF THE GRIP OF TYRES TO THE ROADWAY COVERED WITH PETROLEUM-DERIVED SUBSTANCES

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Abstract

The area of the roadway covered with petroleum-derived substance is characterized by lowering the grip of tyres of the vehicle to the roadway. In realistic conditions of the road traffic that kind of obstacles are with difficulty noticeable for the driver and sedatenesses constitute the element of surprise which in combination with violent lowering the rate of the adhesion usually results in loss directional of vehicle. The vehicle which fell into the unchecked skid, in particular on the curve of the road is posing a threat to drivers driving up from the opposite direction on account of random migration of such a vehicle to their traffic lane. Driving vehicles on the roadway this way polluted also have limited possibilities of taking defensive action in order to avoid confronting. For the evaluation of the bearing of drivers in understanding violating by them safety rules in the road traffic on the roadway polluted with vehicles with substances mentioned above applying the rate of the adhesion which is appropriate in calculations and simulations is significant to the analysed road situation. In the article so a problem of the selection of this rate was taken relating to the case study of an existing road accident consisting in inducing collision of two vehicles moving along an asphalt wet roadway polluted with petroleum-derived substance - with diesel.

Keywords: *rate of the adhesion, road safety, slide of the vehicle*

1. Introduction

The grip of the tyre of the wheel to the roadway is playing the essential role in the issues concerning the traffic. Simultaneously she has a direct effect to the road safety, this way in the case of braking or car rides along the curve of the road. It is gaining the special significance in the road situations associated with the sudden and unexpected lessening grips of tyres of the vehicle to the roadway. Substances which are polluting the surface of the roadway can indeed influence the change of her characteristics in understanding reducing the adhesion mentioned above. In the course of analysis of the course of a road accident problems with the due selection of the rate of the adhesion of circles of the vehicle are turning up at such situations to the surface of the roadway. The actual value of this parameter in practice during analysis of the case after the end of the considerable time after his becoming known won't usually already be established. One should however aspire to it in calculations to assume the values closest to reality.

Among others petroleum-derived substances belong to mentioned above pollutants of the roadway. Recognizing such substance on the roadway, as dangerous it is unusually difficult for the

driver, since on the dry roadway they are accepting the form of darker stains, and on the wet roadway even from the direct closeness they are unrecognizable [4].

So that kind of obstacles constitute the surprise to the driver undoubtedly what the direct impact on the time of his reaction which in the process can average even has about 1.4 s [5]. The vehicle at that time is moving without the change of the speed and direction of the ride in the response time of the driver and mechanisms of a brake system and managerial [2, 9]. On fig. 1 a view was introduced to the asphalt roadway dry polluted with diesel, and on the fig. of 2 roadways asphalt wet polluted with diesel.



Fig. 1. View of the asphalt roadway dry polluted with diesel [4]



Fig. 2. View of the asphalt roadway wet polluted with diesel

2. Characteristics of the grip of the tyre of the circle of the vehicle to the roadway

Rate of the grip of the tyre to the roadway (meant universally with μ symbol) is a measure of sizes of powers which into the effect of friction can be moved among the circle of the vehicle, but a surface of roadway. This rate is a characteristic size for cooperating "pair" tyre - surface of the roadway. So he constitutes the function of many changeable factors which are made conditional this way on the tyre, as well as the surface of the roadway. There are also load and exploitation conditions not without meaning of interaction of the tyre with the roadway. In the article they paid special attention above all to the factors associated with the surface of the roadway. To most important from them among others a kind of materials applied to the building site given to the surface, that is a grade of binder and aggregates, his structure and the granularity, as well as the shape and the height of grains sticking out above binder are included.

However in types of the surface of hardened roadways they are being favoured, at least a few [5]:

- macro lack and micro irregularities or exclusively micro;
- the macro of the crack and hollows and micro with the subtypes associated with the macro condensation, micro with keen edges of coarse grains;
- macro of the break between large modica and micro lack or with the macro subtype of the crack and the hollow without micro.

On fig. 3 a detailed description of types of hardened surfaces was presented [5].

Type of the surface	Picture	Description
1		The macro lack and microirregularities
2		Exclusively micro
3		Macro (cracks and hollows) and micro
4		Macro and micro like in type 3; small macro condensation
5		Macro (breaks between coarse grains) and micro (keen edges fat grains)
6		Macro (breaks between coarse grains); micro lack
7		Macro (cracks and hollows); micro lack

Fig. 3. Types of hardened surfaces [5]

3. Rate of the adhesion of the circle of the vehicle to the surface of the roadway

A rate of the grip of the tyre is the size analogous to the rate of the friction in mechanics to the roadway. He, as the quotient of power appearing during the move of the wheel of the adhesion are being defined - of tangent of the reaction of the surface to vertical power straining the wheel - of normal of the reaction of the surface of the roadway.

Changes of the value of power while hindering the test were introduced to the tangent on the fig. 4 [5].

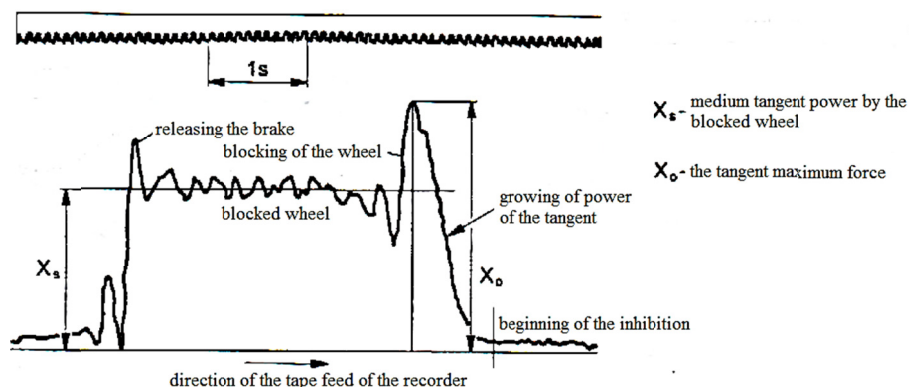


Fig. 4. Changes of the value of power of the tangent while hindering the test [5]

Results of measurements of the value of the rate of the grip of the tyre of the wheel to the roadway depend also on conditions and survey methods. They are most often held with dynamometrical carts or using different tyres on the same surface or also inversely - the same tyre, but other segments of the same surface. On fig. 5 a course of the measurement of the force was introduced to the F_x tangent, with which a cart is being pulled with the fragment of the surface of

roadway [6]. To this surface a stopped car wheel is being pressed, therefore during the measurement the tangent X_K reaction working on the wheel is balancing power by the F_x tangent. Considerable values of the reaction of the X_K tangent are appearing on the dry roadway and on the surface wet and covered with snow, ice or other substance reducing the adhesion wheels are dwindling to roadways. To mark in addition also belongs, that for every cooperating "pair" tyre - surface of the roadway two characteristic values of the rate of the adhesion are appearing [5, 6, 9, 10]:

- rate of the adhesion adjoining which has a maximum value and appearing at the slight slide of the wheel (10-30%);
- this rate on account of the total slide of the blocked wheel is getting the rate of the sliding adhesion which is appearing by the blocked wheel, values smaller than the rate mentioned above of the adjoining adhesion.

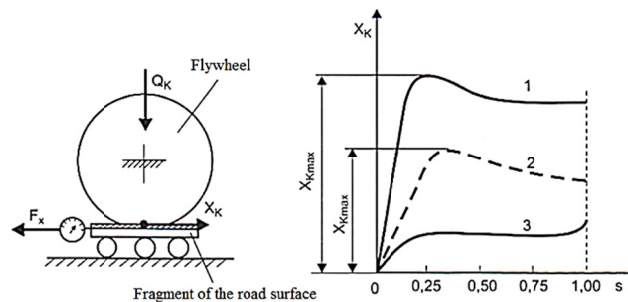


Fig. 5. Dependence of the reaction of the district tangent on the skid and the state of the surface of the roadway: 1 – dry asphalt, 2 – wet asphalt, 3 – snow [6]

Proceeding of the test of the car in the state of the rotary motion to block (of total skid) he is a fast-changeable process and has a transient course, and get measurements of the value of rates of the adhesion on different surfaces are characterized with great scattering of the value. To fig. 6 a course of the rate was introduced to the grip of the tyre of the circle of the vehicle to the roadway in the function of the skid, however to fig. 7 a signalled earlier scattering of the μ factor was presented on different surfaces of roadways [10].

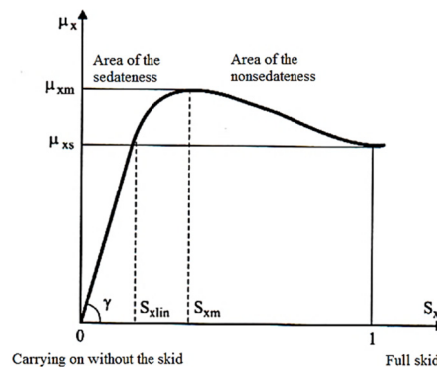


Fig. 6. Course of the rate of the adhesion in the function of the skid [10]

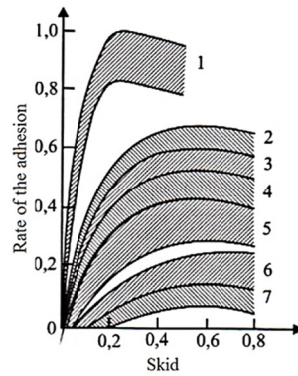


Fig. 7. Values of the rate of the adhesion: 1 - dry asphalt, 2 - dry clay, 3 - dry clayey sand, 4 - wet clayey sand, 5 - wet clay, 6 - mud, 7 - mud with water [10]

4. Data of the rate in the value of the adhesion on the roadway covered with petroleum-derived substance

In practice consultative performing examinations in setting the discussed higher rate of the adhesion directly after the accident, if any it is feasible one should treat getting this type of data, as occasional. Therefore in analyses of road accidents obtained data from examinations after appropriate statistical processing presented is applied in the literature on the subject. They should be farther used in the aspect of them possibly of the best adequacy to the considered event. Results of presented adhesions given in the range of values of the rate on the roadway covered with diesel are pointing at considerable differences. They result among others from differences in the type of the surface, on which they were led. First from analysed data they gave in table 1 [11].

Tab. 1. Delaying braking on the roadway covered with diesel

Surface	Christofferson	Fricke	Limpert
Diesel spilt on wet rough asphalt	-	-	0,25 – 0,3 g
Diesel spilt on wet smooth asphalt	-	-	0,05 – 0,12 g

In new surveys which were being led on the asphalt roadway ensuring the very good grip of tyres of the car to the dry, clean roadway and for clean tyres an average delay of suppressing $8,7 \text{ m}\cdot\text{s}^{-2}$ at using was get ABS. Get results from conducted examinations were presented in table 2 [4].

Tab. 2. Delaying braking on the roadway covered with diesel

Surface	ABS turned on	Without ABS	Standard deviation
Diesel spilt on dry asphalt	0,36 g	0,37 g	0,36/0,1
Diesel spilt on wet asphalt	0,48 g	0,44 g	0,95/0,21

5. Case study - own examinations

In this part of the paper results of calculations and made simulations were introduced for extreme average values of the rate to the adhesion on asphalt covered with the wet surface with petroleum derived substance (with diesel) it is for $\mu = 0.085$ and as an alternative $\mu = 0.44$. Simulations were made using the V-SIM3 program and the database of silhouettes of vector Ratschbacher AutoView vehicles [7, 8]. Up to calculations the following parameters and objects of examinations were accepted:

- curve of the road about the ray of 79 m, asphalt, wet roadway (coefficient of the adjoining adhesion 0.6 and sliding adhesion 0.5);
- area of the roadway covered with diesel (alternative μ rates 0.085 and 0.44);
- initial speeds of vehicles directing at the evaluation of the behaviour $40 \text{ km}\cdot\text{h}^{-1}$;
- Volkswagen Golf III Hatchback 3d, 1.9 TDI (81kW), length 4.02 m, width 1.695 m, height 1.425 m, wheel base 2.475 m, gauge of front wheels 1.45 m and back 1.434 m, a brake system without ABS, tyres 175/70 R13 82 T, the total mass of 1213 kg;
- Mitsubishi Galant VI, 5d 1800 GLSi, length 4.54 m, width 1.695 m, height 1.425 m, wheel base 2.6 m, gauge of back front wheels for 1.46 m, brake system without ABS, tyres 185/70 R14 82 T, the total mass of 1392 kg;
- model of the tired wheel for both objects of examinations leaned on TM-easy [8].

On fig. 8 results were introduced for the rate to the adhesion 0.085. The car is losing Mitsubishi transferring the directional sedateness oneself to an opposite traffic lane, on which for side colliding with vehicle the Volkswagen is pursuing driving up from the opposite direction. However on fig. 9 and 10 changes of the acceleration and longitudinal forces working on wheels were presented.

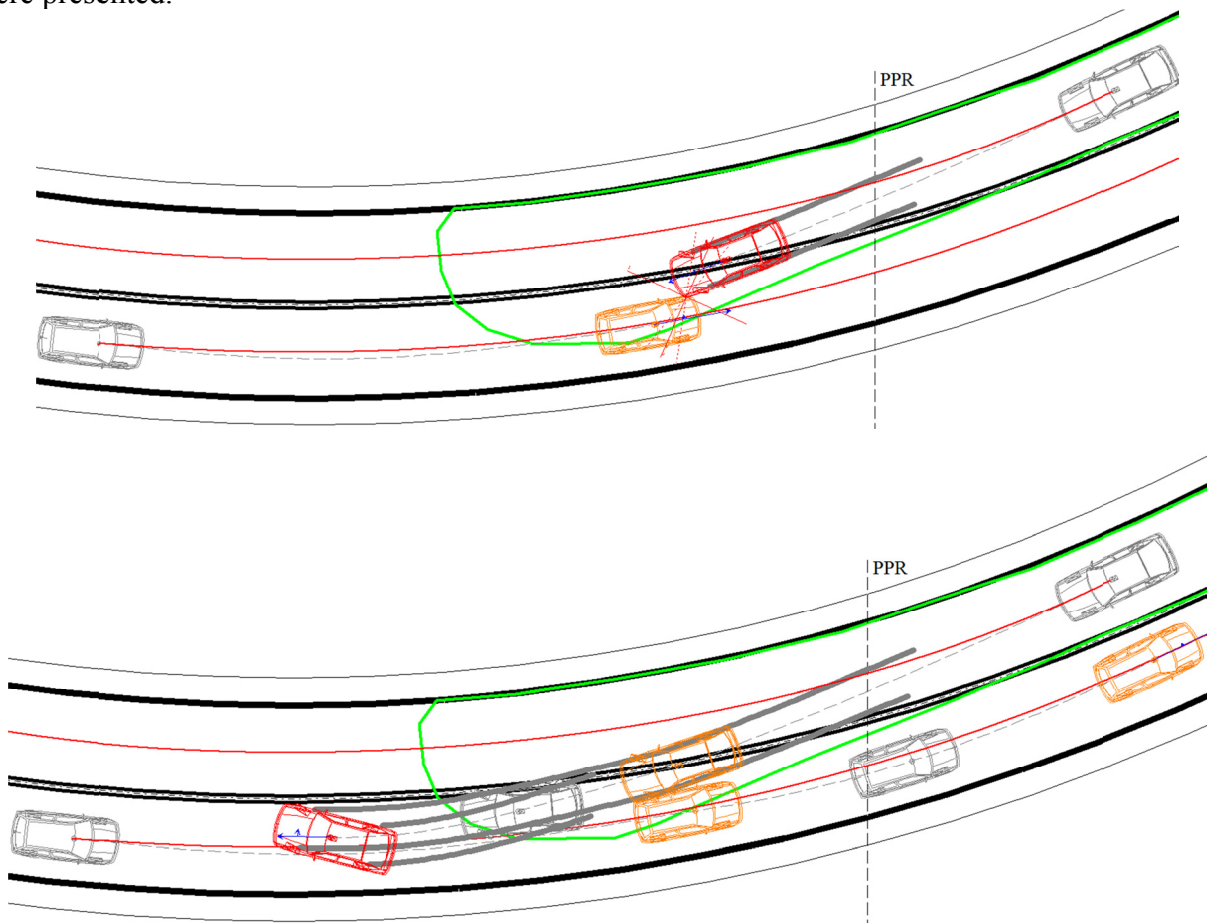


Fig. 8. Loss of the directional sedateness of the vehicle Mitsubishi - $\mu = 0.085$

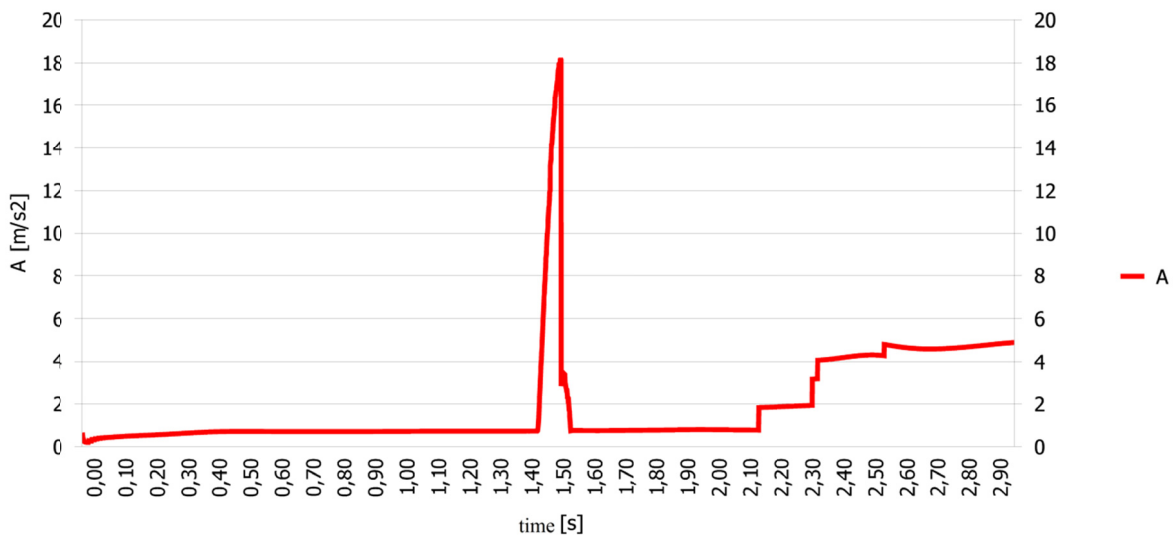


Fig. 9. Changes of the value of hastening the car Mitsubishi - $\mu = 0.085$

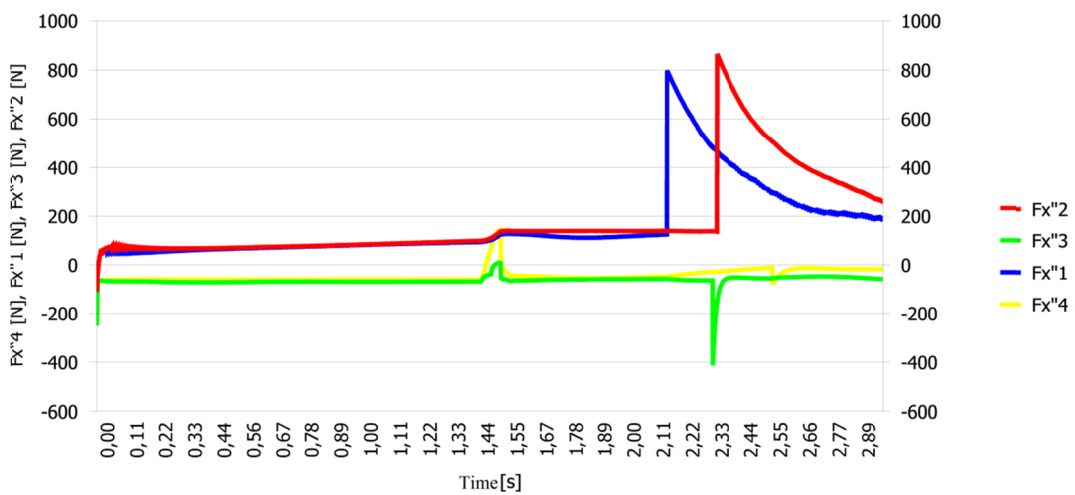


Fig. 10. Changes of longitudinal powers on wheels of the car Mitsubishi - $\mu = 0.085$

On fig. 11 results were introduced for the rate to the adhesion 0.44. The car isn't losing Mitsubishi of directional sedateness. Generally speaking relocating him to an opposite traffic lane in which from the opposite direction the car drove up isn't taking place Volkswagen. However on fig. 12 and 13 presented changes of the acceleration and longitudinal forces working on wheels were introduced to Mitsubishi.

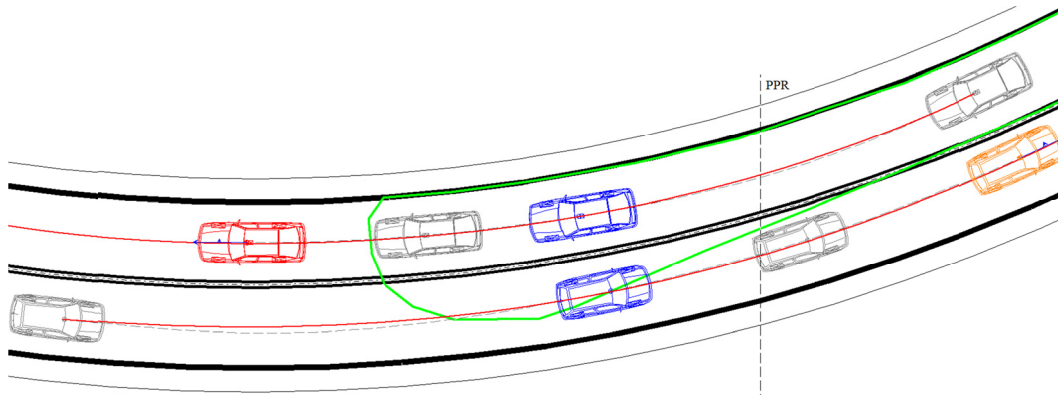


Fig. 11. Keeping of the directional sedateness of the vehicle Mitsubishi - $\mu = 0.44$

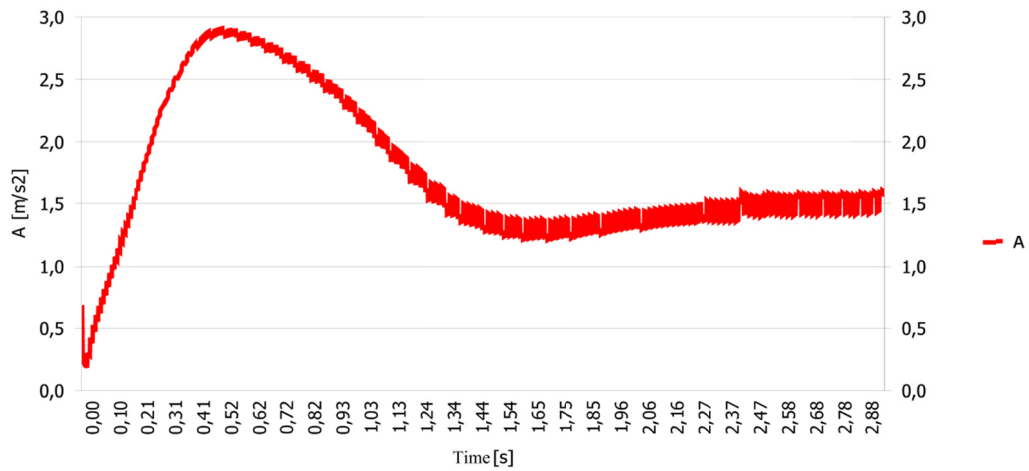


Fig. 12. Changes of the value of hastening the car Mitsubishi - $\mu = 0.44$

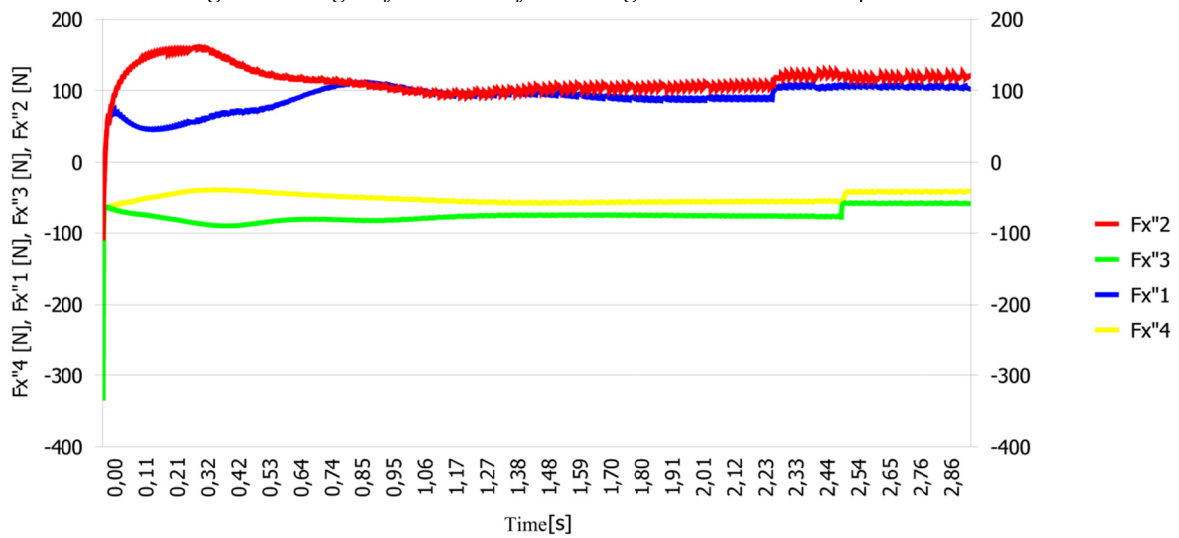


Fig. 13. Changes of longitudinal powers on wheels of the car Mitsubishi - $\mu = 0.44$

On fig. 14 a photograph was introduced to the surface of roadways which he is appointing, that the roadway in the area of the event hadn't been smooth.



Fig. 14. Taking the surface of the roadway helpful for estimating the type for her

6. Conclusions

Made calculations and simulations based on the inspected case study allow for expressing the following conclusions:

- reconstructing real terms of the grip of tyres of the vehicle to the roadway demands applying the appropriate equipment and procedures, and achieving objective results from short-term measurements without the specialist equipment is simplified methods very much dubious [1];
- assuming the appropriate value of the rate of the adhesion of circles of the vehicle to the roadway is with key element for getting correct results of analysis, for assumed extreme values of the μ rate on an asphalt wet roadway polluted with diesel completely different courses of the event were get, it can provoke the effective evaluation of keeping drivers depending on get delaying braking (in this aspect similar problems concern faulty brake systems) [3];
- photographs of the roadway can be, at most helpful in estimating the type of the surface, in the studied case they show that the roadway wasn't smooth, and it is inducing to the party in further analyses of the μ rate with the bigger than smaller value.

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