UDC 530.004

STATUS OF THE ISSUE ON ROAD OPERATING CONDITIONS AND MODES OF MOVEMENT OF THE CONCRETE MIXER TRUCK. CONCRETE MIXER TRUCK ROAD CONDITIONS

Tlegenov Rassul Bolatuly
tlegenovrassul@gmail.com
1st year Master of Standardization, certification and metrology department
ENU named after L.N. Gumilyov, Nur-Sultan, Kazakhstan
Scientific adviser – N. Karbayev

The road operating conditions of the concrete mixer truck during the delivery of ready-mixed concrete to the construction site are very diverse.

When analyzing the smoothness of the concrete mixer truck, it is necessary to take into account the cyclical distribution, the distribution of runs (in%) on various roads, which are controlled by state standard specifications GOST 6875-84 during control tests of trucks.

In the CIS and the Republic of Kazakhstan, roads are qualitatively divided depending on building codes and SNiP P-D.5-82 into five categories or classes, depending on the intensity of their operation and the permissible speeds of the machines. However, the data of GOST 6875-84 and SNiPN-D.5-82 do not adequately characterize roads from the point of view of their influence on the smoothness of the concrete mixer truck. In these documents, indicators characterizing the evenness of the road surface are not regulated. An objective assessment of the evenness of the surface of the road should be made with the obligatory consideration of the influence of irregularities on the vibration of the concrete mixer truck. The impact of the road on the concrete mixer truck is determined by the geometric dimensions, shape and nature of the alternation of bumps.

Depending on the length of the bumps, the roads are conventionally divided into four groups [83]:

1. Impulse - short bumps up to 0.3 m long, the effect of which on the suspension is

similar to the application of vertical force pulses (impacts) to the wheels together with their contact with the road.

2. Potholes - roughness with a length of 0.3 .... 6.0 m, causing intense vibrations of the sprung and non-sprung masses.

Distinguish between short (0.3 ... 1.0 m) and long (1.0 .... 6.0) potholes. The effect of short potholes at operational speeds of movement leads to the appearance of high-frequency vibrations of the sprung section, which occur with insignificant amplitudes at high values of vertical accelerations. Long potholes cause the most intense fluctuations, in which the vertical movement of the sprung part of the machine can exceed the height of the bumps.

3. Bumps- roughness of length 6.0 .... 25 m. Their effect on vibrations of unsprung masses is inessential. The subsurface part when moving along such irregularities experiences mainly low-frequency vibrations, the intensity of which increases with increasing speed.

4. Slopes - roughness longer than 25 m., They do not have a significant effect on the vibration of the concrete mixer truck.

Depending on the height (depth) of the bumps can be divided into three groups:

1. Roughnesses - roughnesses up to 0.01 m in height and up to 0.3 m in length, which do not have a noticeable effect on concrete mixer truck vibrations due to the absorptive capacity of tires.

2. Cavities and ledges - irregularities that cause intense vibrations of the sprung part of the concrete mixer truck and determine, as a result, its smoothness. Such bumps include potholes up to 0.3 m deep and bumps with steepness up to 0.03.

3. Obstacles - potholes with a depth of over 0.3 m and potholes with steepness greater than 0.03, as well as ditches, ditches, rapids, etc. Overcoming obstacles is possible only with a minimally stable speed of movement of the concrete mixer truck. At the same time, violations of the normal mode of operation of the suspension are possible due to breakdowns of springs and wheel breaks from the road surface.

Roughness profile contour of irregularities can be simple, having a certain geometric shape (sinusoidal, trapezoidal, triangular, etc.) or a complex description of which cannot be expressed by simple analytical formulas.

The following patterns are distinguished in the distribution of irregularities along the length of a section on the road surface: periodically alternating bumps of the same size and shape; isolated bumps comparatively large distances from each other; random microprofile - irregular alternation of bumps in various sizes and shapes.

Geometric parameters (dimensions, shape and nature of alternation) of ears and slopes (macro profile) are usually determined during the leveling of the road and graphically depicted as a "longitudinal profile of the road"].

It is convenient to make a generalized qualitative assessment of the evenness of roads in the practice of operating and testing ABSs by conditionally dividing the roads into the following four groups: little-worn roads on which ABSs can move with average speeds v0 exceeding 0.7 (is the maximum speed in terms of the ABS technical specification); heavily worn roads on which average speeds are (0.4 .... 0.7) vmax; broken roads on which average speeds are ¬ 0.2 ... 0.4 rough terrain at which the average speed is not exceeds 0.2 vmax.

Table 1.2

Quantitative characteristics of the classification of roads by the degree of flatness of their surface

Options	Road surface			
	Few worn out	Strong worn out	Broken	Rugged terrain
1 Characteristic of short pulse irregularities up to 0.3 m and a height of more than 0.03 m				
1.1 Number per 1km.	20^-50	504-150	1004-200	over 200
1.2 Height in m: maximum	to 0,05	0,05...0,07	ooo	oo(Л
most likely	0,03.. .0,04	0,03...0,05	0,05...0,07	0,07...
2 Pothole characteristic:				
2.1 Number per 1km.	to 200	2004-500	3004-500	2004-300
2.2 Most likely potholes in m.	0,5...1,5	1,0...2,5	1,5...3,0	1,5...5,0
2.3 Pothole Depth in m .: maximum	to 0,1	OD...0,2	0,2...0,3	over 0,3
Most likely	0,03.. .0,05	0,05...OD	...0,15	>0,15
Rms	to 0,015	0,015...0,03	oo0-1oooo	>0,08
3 Characteristics of bumps: 3.1. Number per 1 km.	to 5	54-10	104-20	>20
3.2 The most probable length in m.	6...9	6...10	6...12	8...16
3.3 Depth in m: most probable	0,03...0,05	OD...0,2	0,3...0,5	0,7...1,2
Maximum	to OD	to 0,3	to 1,0	to 2,0

When calculating the smoothness of the ABS, it becomes necessary to analytically or graphically represent the microprofile function h = f (l), which displays the change in the height of the bumps: h along the length l of the road section.

The microprofile of the road usually has a complex shape with a random nature of the change in the height of the bumps and therefore can only be characterized statistically.

For a comparative assessment of various microprofiles, the zero line — the axis of the argument 1 — is expedient to direct parallel to the “red” leveling line of the road profile through the points corresponding to the average value of the function h (l). In this case, the average value of the microprofile function specified in a section of length

l_0 = 2/(figure 1.14)

$$h_{cp}=(1/2l)\int_{-1}^{+1} 1 \quad (1.1)$$

It will be zero, and the main indicator of the size of the variation of the function - its rms value ks will have a minimum value

$$h_c = \sqrt{\left(\frac{1}{2l}\right) \int_{\_1}^{=1} \text{hdl}} \text{ ^(1/20} \qquad (1.2)$$

The relationship of random values of the function along the length of the road section is characterized by an anti-correlation or simply correlation function, determined from the following expression.

$$Ki = \lim_{\infty}(1/2l) \int_{-l}^{+l} h(l+\Delta)h(l))dl, \qquad (1.3)$$

where $h(l+\Delta)$- the value of the microprofile function with the argument value shifted by the value D (Figure 1.15)

An analysis of formula (1.3) shows that for a zero shift of the argument (Δ = 00) the value of the correlation function will be maximum and equal to the variance h2c of the microprofile function. With an increase in the shift of argument D, the values of the correlation function begin to decrease (Figure 1.16) and after a certain value Δ = Δ_0 it intersects the abscess axis, and then the function values decrease, becoming less than any given number. *h (l)*

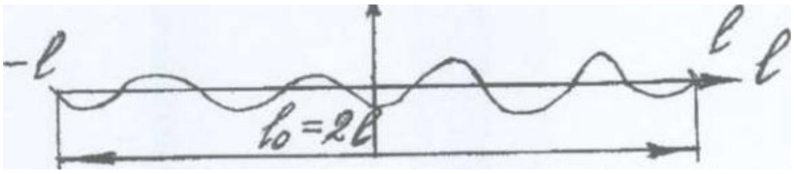


Figure 1.14 - Graph of the function of the microprofile of the road surface, given in section 10 =*21*

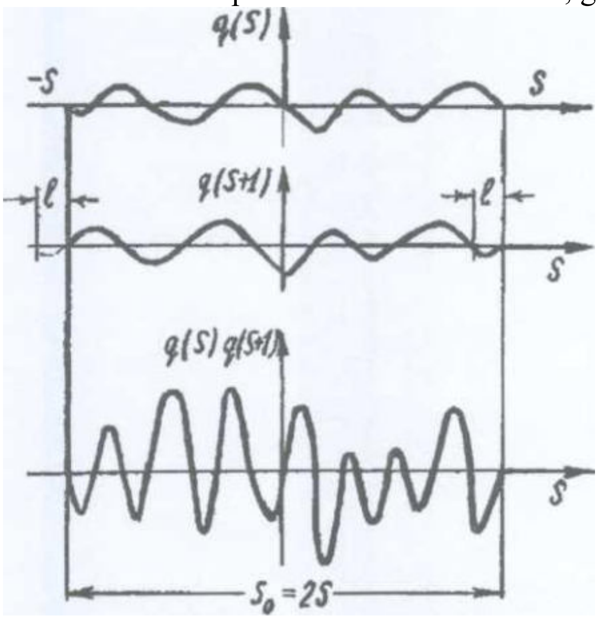


Figure 1.15 - Methodology for determining the correlation function of the microprofile

In mathematical statistics [85, 86], it is argued that for = , it random values of the microprofile function h (I) and h (l +) are random variables that are practically independent of each other. Consequently, for any value of argument I of the microprofile function and for a sufficiently small shift, the quantities h (l) and l (l + Δ) will be mutually related by a certain probability dependence. With an increase in the shift, the tightness of the correlation relationship of these function values will gradually weaken and for Δ> Δ_0 they can already be considered independent random variables.

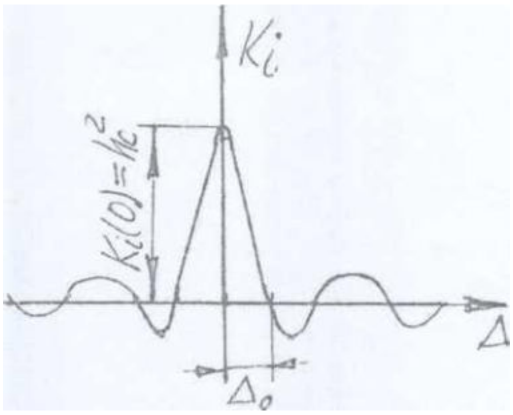


Figure 1.16 - Graph of the correlation function of the microprofile

Table 1.3

The results of the measurement of microprofiles of road sections of the main types of car roads

Road	The number of the calculation formula of the normalized correlation	Coefficients of the normalized correlation function					RMS value of the microprofile function in m.
		A,	A2	*1	*2	Pk	
Broken ground	(4)	0,55 0,85	0,45 0,15	0,085 0,50	0,080 0,20	0,235 2,0	0,03... 0,025...0,0328
Worn Cobblestone Highway with Potholes	(4)	0,953	0,047	0,213	0,049	1,367	0,0252
Cobblestone section of the test track	(4)	0,668	0,336	1,10	10,60	19,71	0,0249
Little cobblestone highway	(5) (4)	-	-	0,45 0,10	-	0,238	0,0135...0,0229 0,0167
Paved highway	(4)	0,85	0,15	0,20	0,05	0,60	0,008...0,0126
Cement - concrete highway	(5)	-	-	0,15	-		0,005...0,0124

Therefore, the length of the segment of the abscissa axis of the correlation function microprofile characterizing the probability the relationship of the height of the bumps h (l) along the length of the road section, may be used as one of the indicators of statistical evenness characteristics of the road in question. Table 1.3 presents the results of measuring microprofiles road sections of the main types of roads [87, 88]. The resulting correlation functions of the microprofile (Figure 1.17) in almost all cases are satisfactorily approximated by the following expression.

$$P_i = K_i/h_c^2 = A_1 l^{-\frac{x1}{\Delta}/} + A_2 l^{-\frac{x2}{\Delta}/} \cos B\Delta \quad (1.4)$$

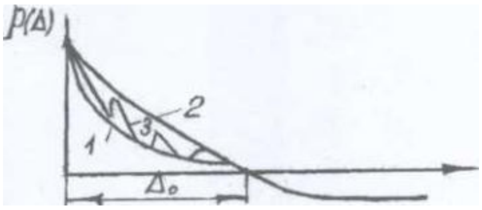
where P -normalized correlation function of the microprofile, for which at Δ = 0 A1 + A2 = 1; Xг иX2 - coefficients characterizing the attenuation this function; $p_к$ is a coefficient characterizing the periodic composition microprofile.

Most normalized correlation functions are approximated by dependence (1.4) in full. It should be noted that in some cases it is possible to approximate the function of microprofiles by simpler expressions and, in particular, having the form $P_i = l^{-x(\Delta)}$(1.5)

or

$$P_i = l^{-x(\Delta)}(cosB_к\Delta \quad (1.6)$$

The experimentally determined values of the coefficients included in formulas (1.4) - (1-6) are presented in table 1.3.



1 - according to the formula 1.5; 2 - by the formula 1.6; 3 - according to the formula 1.4.

Figure 1.17 - Graphs of typical normalized correlation functions of microprofiles of roads

The experimentally determined values of the coefficients included in formulas (1.4) - (1.6) are given in table 1.3. Dependence 1.5 corresponds to a correlation function that decreases monotonically with increasing Δ and asymptotically approaches the horizontal axis (see Figure 1.17). The larger the coefficient x, the faster the function decreases. Due to the fact that the correlation curve of the function does not intersect the abscess axis, to determine the length of the correlation relationship of the roughness heights Δ0, it is accepted that the value Δ0 is determined by the abscissa corresponding to a relatively small value of the normalized correlation function P0 = 0.01. .. 0.05. In formula (1.6), the coefficient x characterizes the rate of decrease of the function, and the coefficient Bk its periodic component. The correlation function of the form (1.4) is the sum of two components: monotonically decreasing (first term) and damped oscillation (second term). For most of the examined microprofiles, the coefficient A2 is less than A1 and therefore the function PΔ has the form of a decreasing curve with superimposed waves of relatively small amplitude.

It should be noted that in order to characterize the effect of irregularities on the running part of the concrete mixer truck, it is necessary to take into account the micro profile of the road surface, measured not on one, but on two track lines. At the same time, as a generalized indicator for evaluating microprofiles, we can, to a first approximation, take the average values of microprofile indicators under the right and left concrete mixer truck wheels.

An analysis of the results of measuring the microprofiles of roads shows that, with a sufficient length of the measurement sections, the normalized correlation functions determined for the trace of the left and right wheels differ little one from the other.

The main difference is manifested in the variances of the right and left microprofiles. Therefore, when calculating the smoothness of the concrete mixer truck, one normalized correlation function should be used for the average dispersion.

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