EXPERIMENTAL DETERMINATION OF THE ASPHALT ROAD PROFILE IRREGULARITIES

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ABSTRACT

Determination of terrain profile is important when studying the model, the vibration on the mobil agricultural unit that occur in the vertical plane of symmetry due to vertical movement (bouncing or vertical oscillations) and rotations around the transverse axis passing through the center of gravity (pitching oscillations).
This paper presents a methodology for the experimental determination of the road profile irregularities. It was considered that the irregularities profile is sinusoidal and were determined the height and length

1. INTRODUCTION

Irregularities in the terrain profile, which has a random character, influence the aggregate fluctuations and sometimes may impose diferent speed. When driving on bumpy terrain with a speed greater than a limited value, due to oscillations, the driven wheel may lose contact with the ground.
The road surface profile is characterized by the following sizes (Figure 1):

- l - irregularities length ;
- h_0 - irregularities height ;

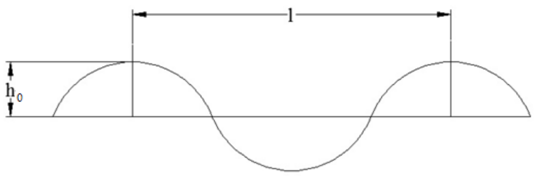

Fig.1. Dimensions that characterize the road profile [1]

2. METHODOLOGY

It may be considered the land profile irregularities are sinusoidal. In this case the profile equation is:

$$h = h_0 \cdot \sin\, \omega \cdot t \qquad (1)$$

where:

$$\omega = \frac{2\pi v}{l} \qquad (2)$$

where: v – is the speed of the aggregate, [m/s].

To determine the terrain profile irregularities that will study the vibrations of the tractor – equipment for deep soil loosening aggregate using a graduated scale length 4 m, two supports, a level and a ruler. Place the ruler on the supports, check its horizontal position with a level and then, with the roulette, measure the height of irregularities of 100 to 100 mm (figure 2).

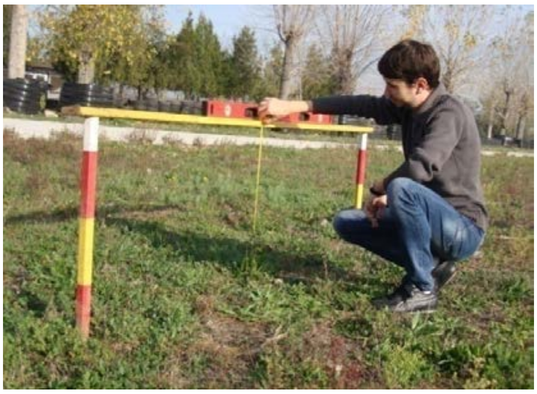

Fig.2. Determination of terrain profile irregularities

On a length of 10 m on a asphalt road we made n = 100 determinations of the distance h measured from the horizontal ruler to the ground. From the set of measured values the gross errors h^* must be removed by using Romanovski test [2], [3].
To do this we have to calculate the empirical standard deviation s for the $n-1$ assuming that the measurement results are not affected by gross errors, using the relation:

$$s = \sqrt{\frac{1}{n-2}\sum_{i=1}^{n-1}(x_i - x_m)^2} \quad (3)$$

Knowing the average values h_m for the $n-1$ remaining values after removing the value h^*, suspected to be affected by gross errors, calculate the ratio:

$$t = \frac{\left|x^* - \bar{x}\right|}{s} \quad (4)$$

For a confidence level of $P=0.95$ and n = 100 number of experiments to determine the critical value t (n, P) = 1.994 [2],[3].
If:

$$t > t(n, P) \quad (5)$$

we will remove the value h^* to be free of gross errors,with a level of confidence P.
In the set of measured values we did not identify values affected by gross errors.

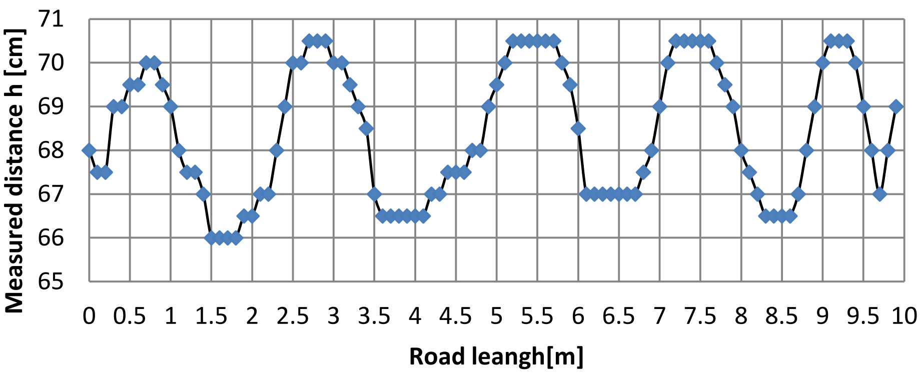

Fig.3.. Distance h measured from the horizontal ruler to the asphalt road

Table .1 shows the measured values of h and the irregularities height $h_0 = h - h_m$ where $h_m = 69.82$ *cm* is the average of the measured variables.

Table 1. The profile of the asphalt road irregularities

Nr.	h [cm]	h_0 [cm]	Nr.	h [cm]	h_0 [cm]	Nr.	h [cm]	h_0 [cm]	Nr.	h [cm]	h_0 [cm]
1	68	-1.82	26	70	0.18	51	69.5	-0.32	76	70.5	0.68
2	67.5	-2.32	27	70	0.18	52	70	0.18	77	70.5	0.68
3	67.5	-2.32	28	70.5	0.68	53	70.5	0.68	78	70	0.18
4	69	-0.82	29	70.5	0.68	54	70.5	0.68	79	69.5	-0.32
5	69	-0.82	30	70.5	0.68	55	70.5	0.68	80	69	-0.82
6	69.5	-0.32	31	70	0.18	56	70.5	0.68	81	68	-1.82
7	69.5	-0.32	32	70	0.18	57	70.5	0.68	82	67.5	-2.32
8	70	0.18	33	69.5	-0.32	58	70.5	0.68	83	67	-2.82
9	70	0.18	34	69	-0.82	59	70	0.18	84	66.5	-3.32
10	69.5	-0.32	35	68.5	-1.32	60	69.5	-0.32	85	66.5	-3.32
11	69	-0.82	36	67	-2.82	61	68.5	-1.32	86	66.5	-3.32
12	68	-1.82	37	66.5	-3.32	62	67	-2.82	87	66.5	-3.32
13	67.5	-2.32	38	66.5	-3.32	63	67	-2.82	88	67	-2.82
14	67.5	-2.32	39	66.5	-3.32	64	67	-2.82	89	68	-1.82
15	67	-2.82	40	66.5	-3.32	65	67	-2.82	90	69	-0.82
16	66	-3.82	41	66.5	-3.32	66	67	-2.82	91	70	0.18
17	66	-3.82	42	66.5	-3.32	67	67	-2.82	92	70.5	0.68
18	66	-3.82	43	67	-2.82	68	67	-2.82	93	70.5	0.68
19	66	-3.82	44	67	-2.82	69	67.5	-2.32	94	70.5	0.68
20	66.5	-3.32	45	67.5	-2.32	70	68	-1.82	95	70	0.18
21	66.5	-3.32	46	67.5	-2.32	71	69	-0.82	96	69	-0.82
22	67	-2.82	47	67.5	-2.32	72	70	0.18	97	68	-1.82
23	67	-2.82	48	68	-1.82	73	70.5	0.68	98	67	-2.82
24	68	-1.82	49	68	-1.82	74	70.5	0.68	99	68	-1.82
25	69	-0.82	50	69	-0.82	75	70.5	0.68	100	69	-0.82

With the data in Table 1 we represented graphically the variation of the distance measured from the horizontal to the road irregularities based on the length of the road

Figure 4 shows the the variation the asphalt road height irregularities based on the length of the road

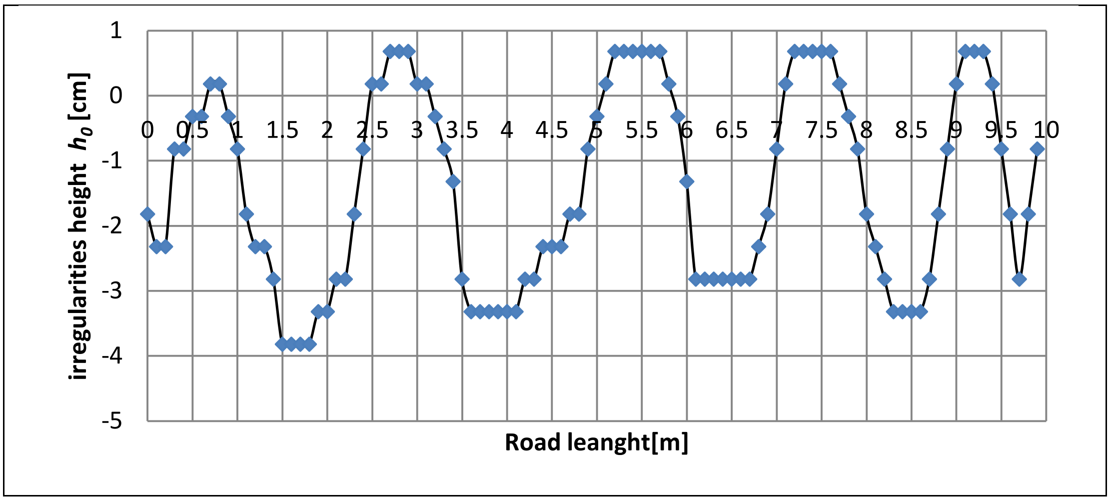

Fig.4. Height h_0 of the asphalt road irregularities

Half-profile road bumps irregularities are calculated with:

$$l_{1i} = L_{i+1} - \mathrm{L}_{\mathrm{i}} \tag{6}$$

where: L_i - is the measured distance from the origin of the path length to the point i where the irregularities height is equal to zero. There were obtained 11 values shown in Table 2.

Table 2. Semi-length irregularities values

Nr.	L_i [m]	l_{1i} [m]	Nr.	L_i [m]	l_{1i} [m]
0	0.7	-	6	7.1	1.2
1	0.9	0.2	7	7.7	0.6
2	2.45	1.55	8	8.9	1.2
3	3.1	0.65	9	9.45	0.55
4	5.1	2	10	10	0.55
5	5.9	0.8			

The true value of the height and length of the field irregularities is determined as the average values of the measured values. The real value for the two measured variables is:

$$h_0 = 0{,}01669\ m$$
$$l_1 = 0{,}94\ m \quad (7)$$

The asphalt road surface profile is characterized by the following sizes:

- *l = 1.88 m* irregularities length;
- h_0 *= 16.69 mm* irregularities height.

3. CONCLUSIONS

- Approximation of the irregularities in the terrain profile with a sinusoidal function is recomended to study vibrations for a mobil agricultural unit ;
- The number of measured values depends on the accuracy of approximating the height and length of the irregularities and level of confidence of their determinants
- The method presented is simple, requires no expensive equipment and high qualified personnel to perform measurements for road profiles.

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