STUDYING OF VIBRATIONS, ACTING OF THE DRIVERS OF THE ROAD-BUILDING MACHINERY AND AUTOMOBILES

ИЗСЛЕДВАНЕ НА ВИБРАЦИИТЕ, ДЕЙСТВАЩИ НА ВОДАЧИТЕ НА ПЪТНО-СТРОИТЕЛНИ МАШИНИ И АВТОМОБИЛИ

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Abstract: *The vibrations caused by road-building machinery affect drivers equally harmful to the three axes of the coordinate system. Assessment of exposure to vibration hand-arm system is based on the calculation of daily exposure value for the 8-hour A (8).*

Keywords: VIBRATIONS, ROAD-BUILDING MACHINERY, AFFECT DRIVERS, HAND-ARM SYSTEM.

1. Introduction

The impact of vibration on humans is associated with the oscillation of certain internal variable force effects on the machine, or on its system. At the beginning of this kind of oscillations may be associated not only with power but with kinematic excitation, typically for vehicles in their movement on rough roads.

The minimum requirements to protect workers from existing or potential risks to health and safety associated with exposure to vibration at work are set out in Ordinance № 3 of 5.05.2005, Acording to this Ordinance, the vibrations are divided into vibration system "hand -arm" and vibrations transmitted to the whole body. [2]

Vibrations of the whole body disturbs the human body. It is normalized by taking into account the source of the impact that a sign is divided into:

- transport - result from movement of machinery in areas and roads;

- transportation technology - are formed during operation of machines performing technological operation in stationary and/or moving of a specially prepared portion of the production area or industrial site;

- technology - arise when working on stationary machines or transmitted jobs, havent got source of vibration.

The purpose of this study is to identify and demonstrate the values of vibration experienced by drivers of different types of road-building machinery (trucks, excavators, tractors and other vehicles).

The transport machineries and vehicles are randomly selected, the only condition for their research is more common types operating in the region of Smolyan.

In accordance with the ordinance, the values of vibrations of hand-arm system should not exceed the daily exposure limit value set for the 8-hour (5 m/s^2) and the daily exposure value action specified period 8 h (2,5 m/s^2).

The values of the vibrations of the whole body must not exceed the daily exposure limit value set for the 8-hour (1,15 m/s^2) and the daily exposure value action set for the 8-hour (0, 5 m/s^2).

2. Theoretical formulation and methodology of the study

Used in the article terms and definitions of Ordinance № 3 of 5.05.2005, and BDS EN ISO 5349-1 Vibrations: exposure, daily value of exposure action, daily value of exposure set for the 8 hours (A (8) or $a_{hv(eq,8h)}$, (m/s^2), the total value of vibration frequency weighted rms acceleration a_{hv}, (m/s^2), RMS acceleration frequency-weighted vibration in hands, one axis (a_{hw}), (m/s^2).[3]

Assessment of exposure to vibration hand-arm system is based on the calculation of daily exposure value for the 8-hour A (8).

The daily vibration effect is obtained from the magnitude of vibration (vibration of a total amount) and the length of day effects.

Daily exposure value for the 8-hour is calculated by the formula:

$$A(8) = a_{hv}\sqrt{\frac{T}{T_0}}, \qquad 1)$$

where:

A (8) is the daily amount of exposure to vibration in m/s^2;

a_{hv} - total vibration values in m/s^2;

T - total daily duration of exposure in h (s);

T_0 - duration 8 h (28 800 s).

The total value of the vibration is determined by the formula:

$$a_{hv} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2}, \qquad 2)$$

where:

a_{hv} is the total value of vibration in m/s^2;

$a_{hwx}^2, a_{hwy}^2, a_{hwz}^2$ are frequency-weighted RMS acceleration in m/s^2, measured in three axes - x, y and z the vibrating surface in contact with the hand.

From the cited methods, it is clear that the longer the time of impact, the driver will be exposed to a higher exposure and at eight-hour working day, the exposure will be equal to the total value of the vibrations - a_{hv}, and when the length of the impact is less than 8 hours, it is necessary recalculated leftmost value of the daily exposure to vibrations A (8).

Measurement of vibrations in the system "hand-arm" and the whole body were made with a meter conforming to ISO 8041. Device is calibrated by an accredited laboratory valid until 2015. Before each measurement, the device is controlled with vibrokalibrator, which is also calibrated by an accredited laboratory valid till October, 2014

The apparatus allows measurements to be made in three axes simultaneously.

Vibration arm were recorded for the three strands of rectangular coordinate system, as shown in Figure 1. Orientation of the coordinate system in measurements correspond to BDS EN ISO 5349-1.

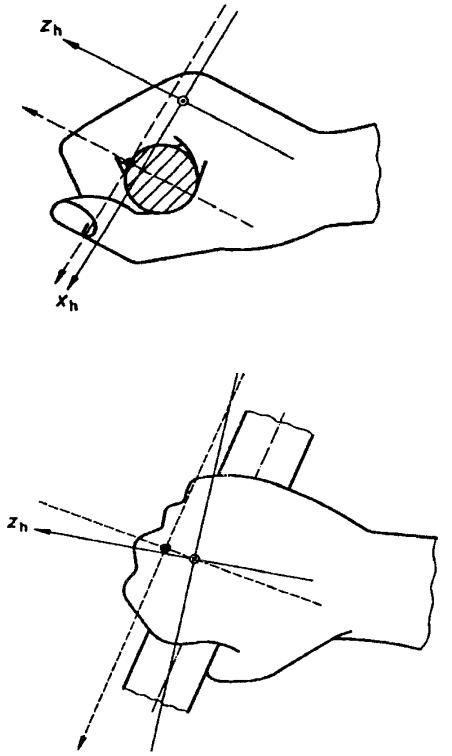

Fig. 1. *Scheme targeting the coordinate system*
Biodynamic coordinate system
Basecentered coordinate system

Methodology in Ordinance № 3 of 5.05.2005, and BDS EN ISO 5349-1 requires the sensor to be placed in areas where there is contact of the body with a vibrating surface. When measuring vibration system "hand-arm", the sensor is located between the arm and the vibrating surface, which in this case the steering wheel.

Drivers of road-building machinery - trucks, excavators, tractors and other vehicles are tested parameters of vibration system "hand-arm." Observed parameters apply to both hands in contact with the steering wheel.

According to standard BDS EN ISO 5349-1, the vibrations in each of the three directions defined by the axes of the rectangular coordinate system shown in Figure 1, are equally harmful and that the same frequency weighting can be used for each axis. Therefore, the risk of damage caused by vibrations, transmitted by hand, are evaluated by the total value of the vibrations, a_{hv} calculated from three frequency components weighted (for the individual axes) of the acceleration of a surface, which is in contact with the arm.

In that standard is assumed that the method for obtaining the total value of the vibrations, which is equivalent to the energy for a period of 8 hours, the appropriately reflects the relationship between the different sizes of the vibration and the duration of the daily action.

3. Analysis of the results of studies of production of vibration

The purpose of the statistical survey is to identify and demonstrate the level of vibration experienced by drivers of different types of road-building machinery (trucks, excavators, tractors and other vehicles), without focusing on the duration of exposure. They focused reported and registered by the device totals vibration a_{hv} and RMS acceleration $a_{hwx}^2, a_{hwy,}^2 a_{hwz}^2$ measured of the three axes - x, y and z the vibrating surface.

Conditions under which the measurements were performed are the same for the groups of machines: type of road surface (asphalt, stone, rough road); movement of the car (loaded or unloaded, in no time flat, horizontal gradients); state of the road surface (wet, dry, snow, smooth, rough, flat, downhill, uphill) and instantaneous technical condition of machines.

The researches has been aimed to determining exposure, which requires measurement of the vibration level for the time of impact, i.e. for the entire period of operation of the machines, the data presented in this article apply only to the level of vibration measurement time of 30 min.

Of each machine have been studied a number, and reported by the device parameters are averaged for each species.

Object of study in this article the vibration during the work in the operating conditions of the following types of road construction machines and vehicles:

- excavator: excavator "JCB" - 4 pcs.; wheel excavator "ATLAS 1304" - 2 pcs.; front loader "ATLAS 52 D" - 2 pc.; mini excavator "Bobcat" - 2 pcs.;

- Tractors wheel - "Universal" 651 M - 2 pcs.; UMZ 6l - 2 pcs.; "TK-80" - 2 pcs.;

- Tractors chain - T 170-1 pc.; DT 75 - 1 pc.

- Trucks: KAMAZ 5511-12 pcs.; DAF cf 85-5 pcs.; MAN TGS - 10 pcs.; STEYR 91; IFA L60; IFA W 50; Mercedes 914; Mercedes 409.

In carrying out a statistical measurements are made as one of the two factors of the said standard, which affects the impact of the vibration arm, namely the magnitude of the vibrations. The parameters considered were: the total value of the vibration of hand-arm system, frequency-weighted RMS acceleration in m/s^2, measured along three axes - x, y and z of the hand-arm system.

Table 1. Results of measurements

Types of machines	Source of vibrations	a_{hw} - RMS acceleration of the frequency weighted vibration axis ", (m/s^2)			a_{hv} - Total vibration frequency weighted rms acceleration, (m/s^2)
		x	y	z	
Excavators	Backhoe „JCB”	0,31	0,33	0,15	0,48
	Wheel excavator „ATLAS 1304	3,15	4,01	2,99	5,91
	Front loader „ATLAS 52 D	2,14	3,23	2,45	4,58
	Mini excavator "Bobcat"	1,87	0,93	0,89	2,27
Wheeled tractors	Universal 651 M	3,27	3,71	1,82	5,27
	UMZ 6JI	2,75	3,38	2,22	4,89
	TK-80	4,72	6,83	9,25	10,68
Crawler tractors	T 170	4,88	5,21	4,26	8,31
	DT 75	4,25	4,83	3,67	7,41
Trucks	KAMAZ 5511	2,51	1,48	2,47	3,82

	DAF cf 85	0,77	0,93	0,51	1,31
	MAN TGS	0,63	0,71	0,41	1,03
	STEYR 91	1,32	2,29	0,99	2,82
	IFA L60	2,51	1,48	2,47	3,82
	IFA W 50	1,12	0,74	0,68	1,50
	Mercedes 914	1,87	2,32	1,06	3,16
	Mercedes 409	1,84	2,23	1,08	3,09

Results obtained from the survey were processed using methods of mathematical statistics and probability theory, and are summarized in tabular and graphical dependencies.

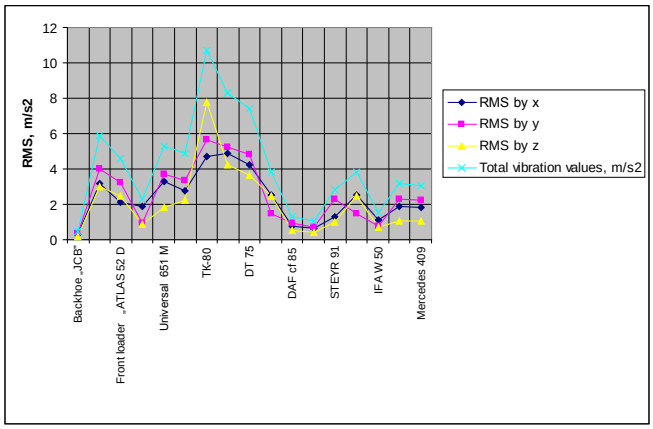

***Fig.2**. Changing of vibration direction for different types of handling equipment*

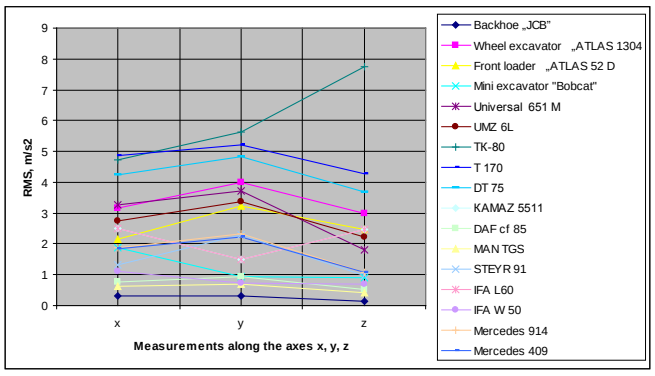

***Fig. 3**. Distribution of level of vibration for different types of transport vehicles in the direction Lenin*

4. Conclusion

1. From the measurements, calculations and built graphical relationships shows that in the tractors levels of vibration of the "hand-arm" are higher than other tested machines.

2. Investigations show that the vibration measured on vehicles and road construction equipment are higher in tractors and trucks from older models.

3. Vibration system "hand- arm" are higher in axis "y" in the majority of the machines.

6. References

[1] Staneva G., L. Stanev "Influence of vibrations in a vehicle on the functional and physiological state of the driver", Smolyan, CC-2004, p. 220-224.

[2] Ordinance № 3 of 5.05.2005 on the minimum requirements for the provision of health-veto and safety of workers on the risks related to exposure to vibration.

[3] BS EN ISO 5349-1 Vibrations. Measurement and evaluation of human exposure to vibration in the hand.

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