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STUDY OF THE LEVEL OF VIBRATION PRODUCED BY THE BELT INSTALLATIONS USED ON THE DUMP MACHINE TYPE A2RsB 12500x95

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Abstract: *Vibrations are dynamic phenomena that arise in elastic media following a local excitation and that manifest themselves through the propagation of the excitation inside the medium in the form of elastic waves. Controlling the level of vibrations is necessary because they have negative effects on the whole system. The vibrations produced by the belt installations used in the dump machines A2RsB 12500x95, through propagation, can have negative effects on other components of the machine as well as on the personnel who service the equipment.*

Keywords: *Vibration, belt installations, effects, dump machinesy.*

1. INTRODUCTION

Vibrations are unwanted movements that produce noise or high mechanical stress. Vibrations have negative effects on the environment, people, machines and buildings.

In order to be able to control the level of vibrations, we must know their frequency and amplitude. These elements have negative effects on the good functioning of machines and equipment, affecting the degree of wear and working precision.

Exceeding the maximum permissible vibration limits has negative influences on human health. They can lead to a reduction in work productivity but also to certain medical conditions such as injuries to parts of the body, pain, etc.

The vibrations produced by machines and equipment during their operation have different causes, such as the nature of the technological process, the principle of operation, the mode of operation, various errors in the execution and assembly of the components, and last but not least, their degree of wear.

Equipment vibrations are transmitted to other equipment through the support systems.

The vibrations produced by belt conveyors are structural vibrations. They are generated by creating the wave effect that is propagated in the metal structure of the reduced rigid.

2. THEORETICAL CONSIDERATIONS

Soundproofing panels used in noise shielding acts as a monopartition.

Isolator panel can be modeled as a homogeneous tile referring to a system of axes Oxyz and normal wave radiation directly enters a vibratory motion in the direction Ox simultaneously bending wave propagation.

Considering excitement bending waves in one direction, the bending moment M = MZ to give the appearance of a strong variable in the direction Ox:

$$F = \frac{\partial M}{\partial y};\ \frac{\partial^2 x}{\partial y^2} = -\frac{M}{B}, \tag{1}$$

in which:

$$B = \frac{El_y}{1 - v^2} = \frac{Eh^3}{12(1 - v^2)}$$

It is the plate rigidity per surface unit where: E - Young module's; v – coefficient of Poisson.

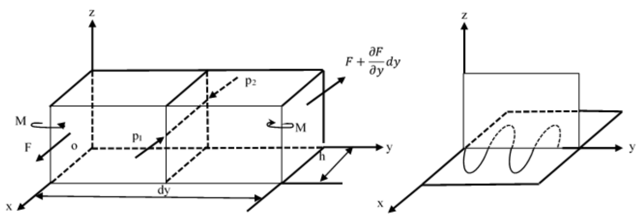

Figure 1: Graphical representation of the forces occurring in a homogeneous plate

The equation of motion of the unitary wall element after the division with surface plan yOz (dA = l dy) is:

$$m\ddot{x} = p_1 - p_2 + \frac{\partial F}{\partial y}, \tag{2}$$

Where m=l·l·h, and after using the expression (1), becomes:

$$m\ddot{x} = p_1 - p_2 - B\frac{\partial^2 x}{\partial y^2}, \tag{3}$$

Provided that particular air wall surface sp to not detach is:

$$\frac{dx}{dt} = v = Ve^{i\omega t}, \tag{4}$$

Integrated which leads to expression:

$$x = \int v dt = \frac{1}{i\omega} Ve^{i\omega t} = \frac{v}{i\omega} \tag{5}$$

Replacing (3) in (2), we obtain:

$$m\frac{dv}{dt} = p_1 - p_2 - \frac{B}{i\omega}\frac{\partial^4 v}{\partial y^4} \tag{6}$$

from where,

$$p_1 - p_2 = i\omega m v + \frac{B}{i\omega}\frac{\partial^4 v}{\partial y^4}. \tag{7}$$

This raises a bending wave which is transmitted along the axis Oy.

These bending waves occur due to vibrations make sound-insulating screen where they fall on different angles of incidence θ, which make it appear a phase shift in the direction Oy. The phase angle difference is due to the road $Dr = y sin\theta$.

Speed v of air particle in contact with points will be expressed by Dr as follows:

$$v = Ve^{i\omega\left(t - \frac{\Delta r}{c}\right)} = Ve^{i\omega\left(t - \frac{y sin\theta}{c}\right)}$$

In this case results:

$$\frac{\partial^4 v}{\partial y^4} = \left(\frac{\omega}{c} sin\theta\right)^4 v,$$

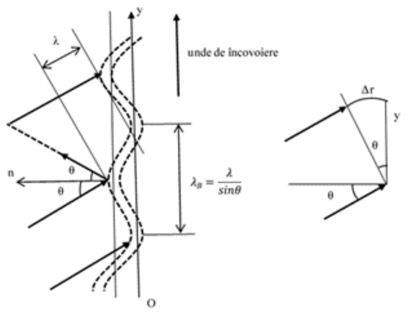

Figure 2: Transmission of bending wave in a homogeneous plate

Expression (6) become

$$p_1 - p_2 = \left(i\omega m - i\frac{B\omega^3 sin^4\theta}{c^4}\right) v. \tag{8}$$

It has specific nature wave impedance containing reactant:

Inertion ω m

Mechanical compliance $\left(\frac{B\omega^3 sin^4\theta}{c^4}\right)$

It will be considered critical if the pressure is transmitted entirely through wall, so p1=p2.

So:

$$\frac{\partial^4 v}{\partial y^4} = \omega^2 \frac{m}{B} v \tag{9}$$

Wave velocity bending the wall is:

$$C_B^4 = \omega^2 \frac{B}{m};\ C_B = \sqrt{\omega}\sqrt[4]{\frac{B}{m}} = \sqrt{\omega}\sqrt[4]{\frac{EIy}{m(1-\vartheta^2)}} \tag{10}$$

Introducing (9) in (10) equation become:

$$\frac{\partial^4 v}{\partial y^4} - \left(\frac{\omega}{C_B}\right)^4 v = 0 \tag{11}$$

Which leads to integrated overall solution:

$$v = C_1 e^{\alpha y} + C_2 e^{-\alpha y} + C_3 e^{i\alpha y} + C_4 e^{-i\alpha y}, \alpha = \frac{\omega}{C_B} \tag{12}$$

From expression (10) results that speed CB flexural wave is dependent upon the angular frequency ω, and condition p1=p2 imposed equation (8), result:

$$1 - \frac{B\omega^2 mc sin^4\theta}{mc} = 0 \implies C_B = \frac{c}{sin\theta} \tag{13}$$

So, for the critic case will result critical velocity of pressure waves which induce wall where bending, forming integral to transmit sound pressure through the wall:

$$\frac{c^2}{sin^2\theta} = 2\pi f_{cr}\sqrt{\frac{B}{m}}, \Longrightarrow f_{cr} = \frac{c^2}{2\pi sin^2\theta}\sqrt{\frac{m}{B}} \tag{14}$$

The lower critical frequency is obtained for θ=π/2 (waves parallel with the wall)

$$(f_{cr})_{min} = \frac{c^2}{2\pi}\sqrt{\frac{m}{B}}. \tag{15}$$

In case of wall h=d,

$$(f_{cr})_{min} = \frac{c^2}{2\pi d}\sqrt{\frac{12\rho(1-\vartheta^2)}{E}}. \tag{16}$$

To avoid sound transmission through the wall without damping aims throwing minimum frequency within the audible frequencies.

3. DUMP MACHINE TYPE A2RSB 12500X95

Dumping of waste materials obtained in the extractive industry can be dumped with the help of dump machine. One such dump machine is the A2RsB 12500x95 type.

Figure 3 shows the construction diagram of an A2RsB 12500x95 type dump machine. It has a theoretical transport capacity of 12500 m3/h and a deposition arm length of 95 m.

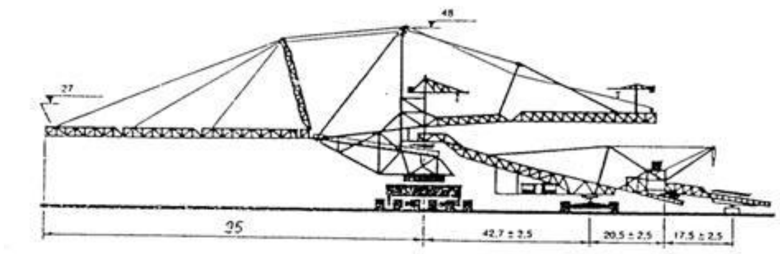

Figure 3: Dump machine type A2RsB 12500x95

The dump machine consists of: movement mechanism on tracks, rotation mechanism, depositing arm actuation mechanism, cable management, counterweight arm anchor cables, anchoring cables of the deposition arm, joints bearings, crane with rotating arm of 5 tf, support cart, cable supporters, electric power supply cable drum, stroke limiters, compressed air installation, centralized lubrication system of the upper part, metal construction: base chassis, platform, mast tower, balancing arm, depositing arm, feeding arm, lane installation, electrical installation, band rider.

4. RESULTS AND DISCUSSION

To determine the level of vibrations produced by the belt installations used on the A2RsB 12500x95 type dump machine on the sound-insulating panels, we performed measurements with the help of the MSR 145 multiparameter instrument. This instrument allows the measurement of several parameters such as the acceleration on the three axes X, Y, Z, both in 2G and in 10 G as well as temperature, humidity and pressure.

Figure 4: MSR 145 multiparameter instrument

The measurements were carried out during the period of rest and operation of the dump machine.

Figure 5 shows the values of the vibration level recorded as a result of the measurements made at the belt installations of the dump machines.

The vibrations obtained during the operation of the conveyor belt installations of the dump trucks have significant values, which are due to the failures of the upper and lower rollers of the conveyor installation. Another source of vibration is the failure of the belt carpet.

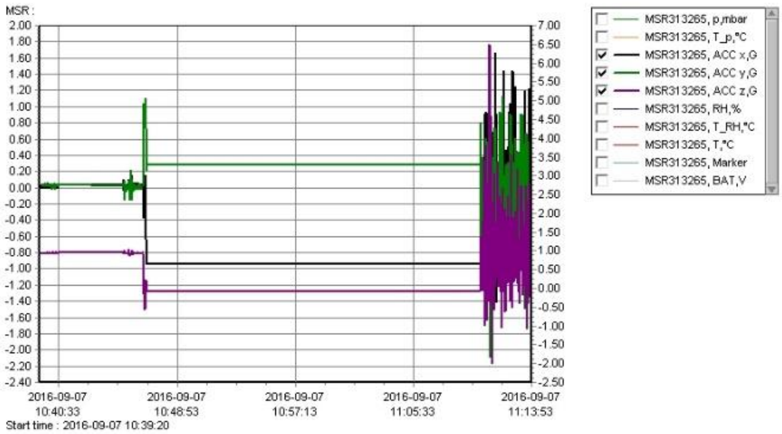

Figure 5: Values of the acceleration amplitude on the three axes x, y and z of the installations of the dump machines

The vibrations produced by the installations of the dump machines are propagated throughout the equipment and can lead to the failure of other components of the dump machines.

Vibrations produced by the dump machines lead to the amplification of the noise. Noise is an important source of pollution in industrial areas that can have significant negative effects on the health of employees.

In order to reduce the level of vibrations, the belt installations of the dump machines must be maintained at optimal operating parameters. For this, it is necessary to replace or repair the defective rollers as well as the replacement of the belt carpet if it is damaged.

Along with the reduction in the level of vibrations, there will also be a decrease in the level of noise pollution produced by the dump machines.

5. CONCLUSIONS

Vibrations are an important source of pollution in the industrial area.

Due to the failures that occur on the belt installations of the dump machines, the vibration level increases.

The vibrations produced by the installations of the dump machines are propagated throughout the equipment and can lead to the failure of other components of the dump machines.

Vibrations produced by dump machines lead to the amplification of the noise.

To reduce the level of vibrations, repair work is required on the belt installations of the dump machines

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