DYNAMIC ANALYSIS OF THE JIGGING SCREEN

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ABSTRACT
This paper focuses on a theoretical and experimental dynamic analysis of the inertial bent jigging screen parameters via analytical and experimental methods. A good correlation is shown between elliptical trajectory and vibration parameters of inertial bent jigging screen movable frame using the both methods: analytical and experimental one.

1. INTRODUCTION

The sieving on jigging screen is very complexly phenomenon, which is difficult to study because there are a lot of parameters that are participating in the working process.

These parameters induced both sieving efficiency and productivity of the jigging screen. The most important parameters are:

- Frequency and amplitude of vibrations
- Screen's angle of dip
- Vibration's kind
  - Elliptical
  - Unidirectional
  - The both
- Particle's motion conditions on sieve surface
- Sieve's length
- Necessary energy to maintain the working vibrating condition

In this paper is shown the gravity center's trajectory of the inertial bent jigging screen movable frame using analytical and experimental methods.

The experimental measurements of the vibration parameters have been determinate by making in evidence of four operating conditions of the jigging screen.

It has been obtained seven graph packs, which describe 40 files of the vibration parameters progress way.

This paper focuses on the two measured parameters :

- Vertical and horizontal displacements and accelerations
- Elliptical trajectories of the sieve-holder movable frame

The phase angle between the vertical vibration and the horizontal one has been determined following the vibration parameters experimental recordings.

It has been find that the ellipse main axis is nearly to the vertical direction.

2. ANALYTICAL STUDY OF INERTIAL BENT JIGGING SCREEN VIBRATIONS

In sieving practice the inertial bent jigging screen is very prevalent. The physical model is shown in the figure 1.

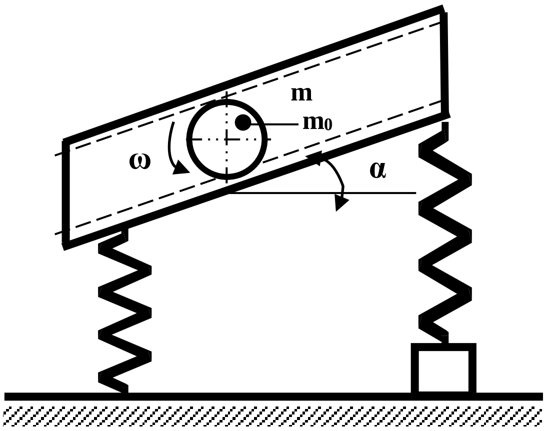
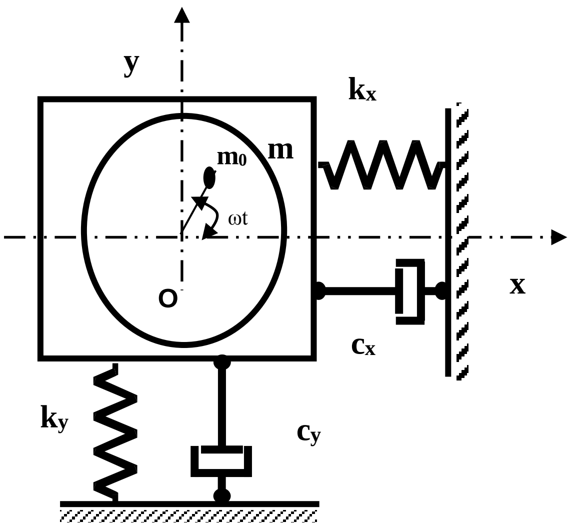


Fig.1. Physical model of the inertial bent jigging screen

From the physical model of the inertial bent jigging screen has been proposed the dynamical



model which is presented in the figure 2.

Fig.2. The dynamical model of the inertial bent jigging screen

In order to establish the differential equations of the motion, there are presented the following notations:

m - mass of the movable sieve-holder frame with the feed material ,, m_a "
m_o - mass of the eccentric
ω - the angular frequency of the eccentric mass
p - own pulsation of the sieve-holder frame
r - the eccentricity of the eccentric mass
x,y - center of the gravity's coordinates of sieve-holder frame
t - time
k_x, k_y - rigidity in horizontal and vertical direction
c_x, c_y - damping in the same directions

F_0 - disturbing force

The equations of Lagrange of the second kind are used in order to establish the differential equations of motion :

$$\begin{cases} (m+m_0)\ddot{x}+c_x\dot{x}+k_x=F_o\cos\omega t \\ (m+m_0)\ddot{y}+c_y\dot{y}+k_y y+F_0\sin\omega t \end{cases} \quad (1)$$

Marking as following:

$$p_x=\sqrt{\frac{k_x}{m+m_0}} \quad (2)$$

$$p_y=\sqrt{\frac{k_y}{m+m_0}} \quad (3)$$

$$n_x=\sqrt{\frac{c_x}{2(m+m_0)}} \quad (4)$$

$$n_y=\sqrt{\frac{c_y}{2(m+m_0)}} \quad (5)$$

the differential equations (1) becames :

$$\begin{cases} \ddot{x}+2n_x.\dot{x}+p_x^2.x=\frac{F_0}{m+m_0}.\cos\omega t \\ \ddot{y}+2n_y.\dot{y}+p_y^2.y=\frac{F_0}{m+m_0}.\sin\omega t \end{cases} \quad (6)$$

The set solutions are :

$$\begin{cases} x=a_x.\cos(\omega t-\varphi_x) \\ y=a_y.\sin(\omega t-\varphi_y) \end{cases} \quad (7)$$

The amplitudes a_x and a_y are :

$$a_x=\frac{m_0.r\omega^2\cos\alpha}{(m+m_0)\sqrt{(p_x^2-\omega^2)^2+4n_x^2.\omega^2}} \quad (8)$$

$$a_y=\frac{m_0.r\omega^2\sin\alpha}{(m+m_0)\sqrt{(p_y^2-\omega^2)^2+4n_y^2.\omega^2}} \quad (9)$$

The phase angles φ_x and φ_y are the following expressions :

$$\varphi_x=arctg\frac{2n_x.\omega}{p_x^2-\omega^2}+k\pi \quad (10)$$

$$\varphi_y = arctg \frac{2n_y.\omega}{p_y^2 - \omega^2} + k\pi \ , \ k \in Z \qquad (11)$$

The centre of the gravity's trajectory of the movable frame is an ellipse with $\mathbf{a_x}$ and $\mathbf{a_y}$ semiaxis.

For the particular case in which the dampings in the system are negligible ($\mathbf{c_x = c_y = 0}$) the relationships (8) leads to the equation of the center of gravity's trajectory reported to the reference system placed in the oscillation center, as following :

$$\frac{x^2}{a_x^{'2}} + \frac{y^2}{a_y^{'2}} = 1 \qquad (12)$$

This equation represents an horizontal ellipse with the semi-axis :

$$a_x^{'} = \frac{m_o r \omega^2}{(m + m_0)(p_x^2 - \omega^2)} \qquad (13)$$

$$a_y^{'} = \frac{m_o r \omega^2}{(m + m_0)(p_y^2 - \omega^2)} \qquad (14)$$

The ellipse is ploted with dashed line in the figure 3.

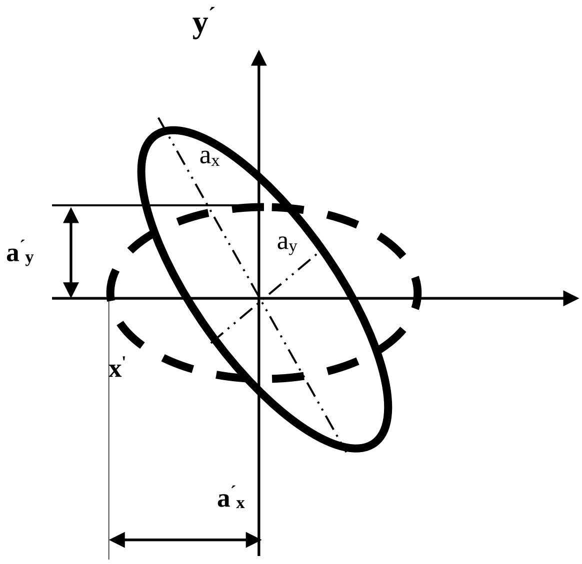


Fig.3. The elliptical trajectory of the movable frame in general and particular case

3. EXPERIMENTAL TESTS

The experimental measurements were done in Gradinari Ilfov gravel-pit for an inertial bent jigging screen with 7,5 m^2 surface.

There are analyzed four operational cases:

1. No load operation without aggregates washing
2. No load operation with aggregates washing
3. Full load operation without aggregates washing
4. Full load operation with aggregates washing

For each case has been recorded the oscillation motion amplitude both vertical and horizontal.

It has been taken over signal section from recording tape using the LabViews software.

It has been obtained the amplitude variation way of the center of the gravity movable frame trajectory for the full load operation with aggregates washing.

There are showed in the figure 4.

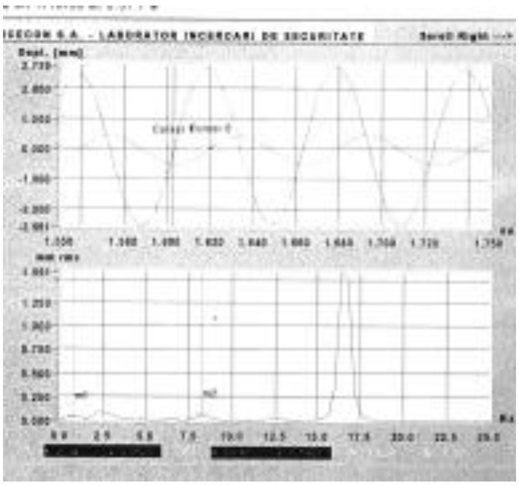


Fig.4. The amplitude variation way of the movable frame center of the gravity trajectory of the inertial bent jigging screen for the full load operation with aggregates washing

Analyzing the figure 4 results that the motion amplitude value is 1,59 mm for operating frequency value equal to 16,4 Hz.

Overlapping the both vertical and horizontal amplitudes of the center of the gravity movable frame of the inertial bent jigging screen, for the full load operation with aggregates washing, results the movable frame center of the gravity trajectory such a ellipse pack that is shown in the figure 5, or like an ellipse who is presented in the figure 6.

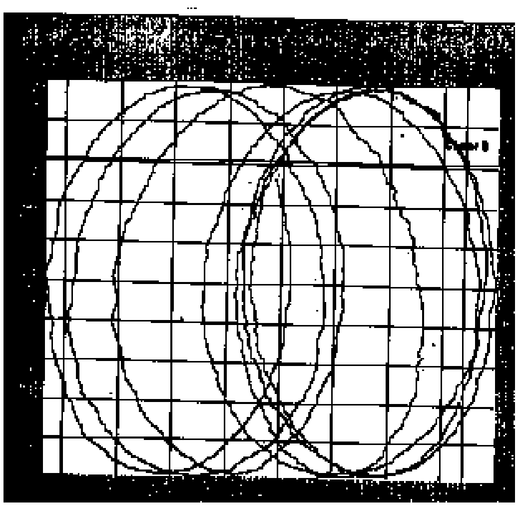


Fig.5. The elliptical pack trajectory of the movable frame center of the gravity of the inertial bent jigging screen for the full load operation with aggregates washing.

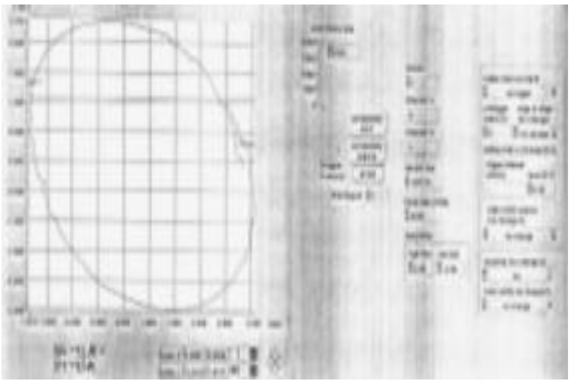


Fig. 6. The elliptical trajectory of the movable frame center of the gravity of the inertial bent jigging screen for the full load operation with aggregates washing

CONCLUSIONS

Following the experimental tests the value for amplitude in horizontal and vertical directions are different.

That facts confirm that the trajectory of the movable frame center of the gravity for the inertial bent jigging screen is an elliptical one.

This trajectory leads to determine the grain's parameters jump-high and length which have an important influence in jigging screen productivity.

REFERENCES

[1] Bauşic Fl. Diaconu Cr. "*Dynamic Models Configuration of Jigging Screen Analysis*", Mecânica Experimental, *3*, *81-84*, Lisbon, Portugal, 1998

[2] Bauşic Fl. ,Diaconu Cr., Legendi A. **„***Considerations concerning the choice of configuration parameters in the plant mechanisms analysis. Proc. of XXII Yugoslav Congress of Theoretical and Applied Mechanics , p. 61-67,vol.2, VRNJACKA BANJA, YUGOSLAVIA*, June 2-7, 1997. Lisbon, Portugal"

[3] Legendi A. Bauşic Fl, Branco F. *„Optimal screening of natural agregates. "* Mecânica Experimental, *(2) , 29-33,* 1997, Lisbon, Portugal"

[4] Legendi A. *„Contribuţii la studiul corelaţiilor optime între parametrii constructivi şi tehnologici la ciururile vibratoare".* Teză de doctorat UTC Buc. 1998.