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PARAMETRIC EVALUATION OF THE VIBRATING SCREENS FOR PERFORMANCE ASSURANCE IN SORTING MINERAL AGGREGATES

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Abstract: *The scope of the research presented in this paper is that of establishing the parametric performance of the inertia vibrating screens used in sorting the mineral aggregates extracted from water basins (river gravel) or, from stone carriers. Essentially, the quality of processing mineral aggregates for construction consists in assurance the purity of sorts on granular classes so that deviation from the medium size of the granulometric particle stands within the limits mentioned by specific standards. In order to achieve this, it is necessary for the inertia vibrating screen, with one or more sieves, to have the optimum values for the throwing coefficient of material onto the screen, so that material passing through screen sieves to be done within the precision limits mentioned by the standard on mineral aggregates. This is the case when fundamental parameters for determining the throwing coefficient are the amplitude and pulsation of the technological vibrations. This paper presents the values of optimum range for the technological vibration's pulsation, so that to achieve constant and stable amplitude and, therefore, the throwing coefficient values to be within the limits of 3-15 for sieve meshes of 5mm – 25 mm.*

Key words: *Technological vibrations, Controlled sorting, Vibrating screen, Granular material, Mineral aggregates.*

1. INTRODUCTION

The main scope of this study results is that of evidencing the influence of technological vibrations amplitude and pulsation of the inertia vibrating screen on the throwing coefficient of the material on the screen, in order to achieve a quality granulometric classification (sorting).

This is why it has been set de calculation model and there have been differentiated the vibrating screen characteristic parameters like: overall weight, stiffness of the suspension springs, tilt angle and static moment of dynamic imbalance that determines the rotational perturbation force for the excitation of the whole system to the technological vibration regime[1,2].

Practically, while experimenting at the river gravel along Argeş river, near Piteşti city, in order to optimize the technological amplitude so that to generate a stable post-resonance regime, there have been done changes to the suspension strings, up to eight variants .

It is to be mentioned that changes in the support system structure, by adding helical suspension spings, resulted in system rigidity increase by discrete values. Thus, there have been matched the amplitude variation on the excitation pulsation and the throwing coefficient variation on the various stiffness discrete values (for the same pulsation)[3,4].

The two families of curves, in accordance, provide the objective possibility for appreciation of the quality parametric level for the studied inertia vibrating screens.

2. PARAMETRIC ANALYSIS OF THE TECHNOLGICAL

It is assumed the functional model of vibrating screen used for continuous flux sorting of the mineral aggregates to be a one degree of freedom system, excited by a rotating inertial centrifugal force. The whole equipment is inclined by α angle, relative to the horizontal plane, and it is supported by four groups made of vertical helical metallic springs, positioned at the four corners of the screen frame.

The mass, elastic, position and kinematic characteristics of the studied vibrating screen are as follows:

m_{01}= 130,44 is the counterweight mass

$m_0 = 2m_{01}\zeta$ =260,88 kg total mass of dynamic imbalances

m = 12430 kg – total mass of the screen (with material on the sieves)

r = 146.84 mm – eccentricity of the mass for dynamic imbalances

k_0= 12 · 10^6 N/m – total stiffness coefficient for the support springs (in initial state)

ζ = 0.15 – fraction of critical damping;

α = 11^0 – tilt angle of the vibrating sieve, relative to the horizontal plane

There have been plotted the graphs for functions A=A(ω) and C=C(ω) depending on the angular speed ω of values between 0 and 500 rad/s by 0.5 rad/s increment, and on the stiffness discrete variation[5,6,7].

The amplitude A is given by relation

$$A = \frac{m_0 r \omega^2}{\sqrt{(k_0 - m\omega^2) + 4\zeta^2 k_0 m \omega^2}} \quad (1)$$

The stationary coefficient is

$$C = \frac{A\,\omega^2}{g\cos\alpha} \quad (2)$$

The graphs of A and C , depending on ω and equivalent constant k, are shown in figure 1and figure 2.

The rigidity is discrete variable as follows:

$k_{-1} = 0.25\ k_0$; $k_{-2} = 0.5k_0$; $k_0 = k_0$; $k_1 = 1.5k_0$; $k_2 = 2k_0$; $k_3 = 4k_0$; $k_4 = 8k_0$; $k_5 = 12k_0$

In figure 1 there is presented the amplitude variation on angular speed ω for different stiffness coefficients, that means discrete variable values[8,9,10,11].

One can notice that amplitude values, for pulsation values within resonance range, are maximum, while for post-resonance the technological amplitude is constant and stable.

The post-resonance regime refers to pulsation values of ω≥ 300 rad/s.

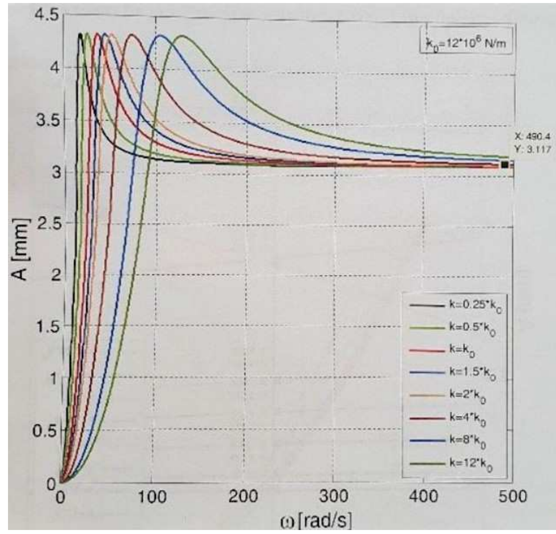

Fig. 1 The amplitude variation on the angular speed ω for different stiffness coefficients

In figure 2 there are shown the values for the throwing coefficient in the vicinity of rotation values mentioned by the equipment producer (in technical characteristics book). This is how there was checked the conformity of throwing coefficient C variation, as function of ω and k[12,13,14,15].

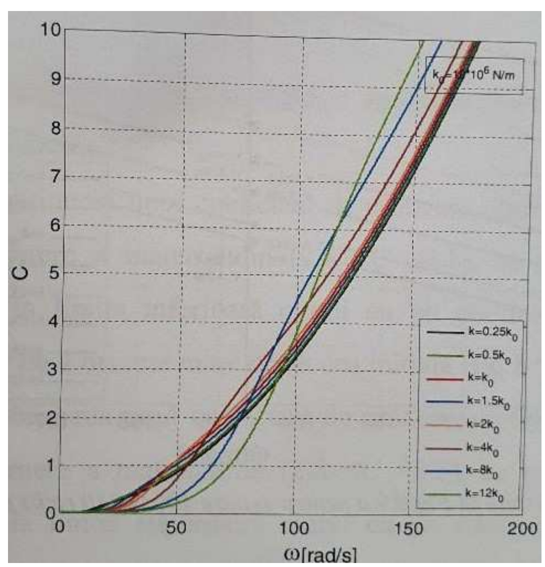

Fig 2 The variation of throwing coefficient on the angular speed ω for different values of the stifeness values

3. CONCLUSION

Based on the analysis of vibration regime and of throwing coefficient of granular particles on the surface of vibrating screen, and considering the case study on a functional model of vibrating equipment, there are the conclusions that follow:

a) the amplitude of technological vibrations for global damping of the system vibrating screen – granular material, at a relative constant value ($\zeta = 0.15$), varies by a curve that reaches maximum value at resonance and, further gets flat, with a constant, stable variation for post-resonance, meaning for

$$\omega > \sqrt{\frac{k}{m}}$$

b) the variation of mineral aggregates quantity by significant mass values, while the technological process is on, requires that for certain technological fluxes to be changed the support system on helical springs, so that to be achieved technological parameters values for an efficient sieving. This is the case that this study points out, more specifically that for different spring packs, the stiffness could be varied to discreet values and it results a family of output curves that, in post-resonance have a well determined value, independent on the support elastic system. This amplitude of the technological regime is

$$A = A_{tech} = \frac{m_0\ r}{m};$$

c) the sieving efficiency is ensured by the value of the throwing coefficient $C \geq 3.5$, that points toward deep analysis for evaluation of the technological vibration's parameters, meaning the amplitude A and pulsation, when the vibrating screen has an inclination determined by the α angle, when referred to the horizontal supporting plane[16,17];

d) discrete change of the support system that corresponds to discrete values of rigidity, according to the data shown in figure 2, evidences that for the same value of, the maximum deviation of throwing coefficient does not exceed 30%. This is why, practically, there is chosen a throwing coefficient with values over, at least, 4.5 so that to compensate the influence of changes of the supporting system[18].

Based on all the previously mentioned, it results that the two different calculation relations, as well as their specific graphs, could stand as defining criteria for the appreciation of vibrating screens performance, used in sorting the mineral aggregates.

4. REFERENCES

[1] Badiu M. - *Analysis of dynamic parameters in inertial vibrating screens*, "SDM 2005", 4th Conference on Machine Dynamics, with international participation, Brașov, mai 2005;

[2] Blanc E.C. – Technologie des appareils de fragmentation et de classement dimensionnel, vol.I Concasseurs et granulateurs, Ed. Eyrolles, Paris, 1974;

[3] Bratu P. - *Mechanical vibrations. Linear modeling systems*. University "Dunărea de Jos" Galați. 1994;

[4] Bratu P., Stuparu A., Popa S., Voicu O., Iacob N., Spânu G., *The Dynamic Isolation Performances Analysis of the vibrating equipment with elastic links to a fixed base*, ACTA NAPOCENSIS - Applied Mathematics, mechanics and engineering, vol. 61, nr. 1, 2018

[5] Bratu P. , *Hysteretic Loops in Correlation with the maximum dissipated energy, for linear dynamic systems by Symmetry 2019*, 11(3), 315; http://doi.org/10.3390/sym11030315-02.03.2019

[6] Bratu P., Dobrescu C., *Dynamic Response of Zener-Modelled Linearly Viscoelastic Systems under Harmonic Excitation by Symmetry 2019*, 11(8), 1050; http://doi.org/10.3390/sym1108105-15.08.2019

[7] Bratu P., Buruga A., Chilari O., Ciocodeiu A. I., Oprea I., *Evaluation of the linear viscoelastic force for a dynamic system (m,*

c, k) excited with a rotating force, RJAV, Romanian Journal of Acoustics and Vibration 39-46, vol.16, no. 1, 2019

[8] Bratu P., *The innovative impact on acoustics, vibrations and system dynamics*, RJAV, Romanian Journal of Acoustics and Vibration 39-46, vol.16, no. 1, 2019

[9] Bratu P., Dobrescu C., *Evaluation of the Dissipated Energy in Vicinity of the Resonance, depending on the Nature of Dynamic Excitation*, RJAV, Romanian Journal of Acoustics and Vibration, vol 16 isse 1, ISSN 1584-7284, 2019, pp.66-71

[10] Bratu P., *Vibrations of elastic systems,* 600 pag., Technical Publishing House, Bucharest, 2000

[11] Bratu P., *Theoretical mechanics,* 860 pag., Impulse Publishing, ISBN 973-8132-57-6, Bucharest, 2006

[12] Bratu P., *Analysis of elastic structures Behaviour to static and dynamic actions*, Impulse Publishing, pag 713, ISBN 978-973-8132-73-3, Bucharest, 2011

[13] Bratu P., *Elastic reclining systems for machinery and machinery*, Technical Publishing House, Bucharest, 1990

[14] Legendi, Amelitta - *Some constructive solutions for vibrating screens for sorting natural aggregates for concrete*. Scientific Communication, IV National Symposium of Construction Equipment,I.C.B., Bucharest, October 8-10, 1991;

[15] Legendi, Amelitta – *Performance criteria for low capacity vibrating screens used for sorting natural aggregates*. Scientific communication, "Dunărea de Jos" University of Galați, Faculty of Engineering Brăila, Brăila October 13-14, 1995.

[16] Legendi, Amelitta, Bratu P., *Criterion for performance level of vibrating quarry's screens*, International Conference Heavy Machinery HM'96 Kraljevo, Yugoslavia, 28-30 june 1996

[17] Stamatiade C., *The influences upon the quality of the mineral aggregates induced by technological vibrations during teh sorting process*, RJAV, vol VI, NO.1/2009

[18] Stamatiade C., *Analysis of the large variety of dynamic regimes of vibrating screens with efficient tehnological performances for optimum screening ranges*. 9th International Acoustics and Vibration Conference. University "Eftimie Mugur", Reșița, sept.2010

EVALUAREA PARAMETRICĂ A CIURURILOR VIBRATOARE PENTRU ASIGURAREA PERFORMANȚEI SORTĂRII AGREGATELOR MINERALE

Rezumat: *Cercetările cuprinse în prezentul articol au drept scop stabilirea performanței parametrice pentru ciururile vibratoare inerțiale pentru sortarea agregatelor minerale extrase din bazine de apă (balastiere) sau extrase din carieră de piatră. În mod esențial, calitatea procesării agregatelor minerale folosite în construcții, constă în asigurarea purității sorturilor pe clase granulometrice de separare astfel încât abaterile de la mărimea medie a particulei granulare să se încadreze în prevederile standardelor de specialitate. Pentru aceasta este necesar ca ciurul vibrator inerțial cu două sau mai multe site să realizeze coeficientul de aruncare a materialului pe sită la valori optime astfel încât trecerea prin ochiurile sitei să se facă în limitele de precizie stabilite de standardul de agregate minerale. În acest caz, parametrii fundamentali pentru stabilirea coeficientului de aruncare sunt amplitudinea și pulsația vibrațiilor tehnologice. Ca urmare, articolul prezintă domeniul optim pentru pulsația vibrațiilor tehnologice în scopul atingerii unei amplitudini constante și stabile astfel încât coeficientul de aruncare să aibă valori cuprinse între 3-15 pentru site cu ochiuri ale căror dimensiuni pot fi cuprinse între 5mm – 25 mm.*

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