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CONTRIBUTIONS TO ESTABLISH THE SCREENING OPERATING CONDITIONS IN THE CASE OF CRITICAL HUMIDITY MATERIAL

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Abstract: *This paper presents some aspects regarding the choice of amplitude and frequency in order to obtain the most favourable vibration operating conditions in the case of screening critical humidity material using an experimental device conceived by the authors. The critical humidity material has its particles under 10mm nominal dimension that have humidity in between 5% - 14%. The results are compared with the amplitude and frequency that result from some diagrams used for normal material (with particles bigger than 10mm and with humidity under 5%, or upper 14%). The presented analyse is valid for screening building material with critical humidity.*

Key words: *sieve amplitude and frequency; building material; critical humidity material.*

1. INTRODUCTION

Establishing the most favourable vibration operation conditions for screening equipment is the essential problem when devising such equipment. The throwing coefficient, the amplitude and the frequency of the vibrations are the decisive factors that influence the vibrating conditions. The research carried out so far (Figure 1) has shown that there are pairs of the values of the rotation speed and of the amplitude for which the quality of the screening becomes optimum, a pair corresponding to each dimension of the mesh of a sieve and specific to a certain type of material. Thus the sieves operate best at high frequencies coupled with small amplitudes for materials with a mainly fine grading, and at small frequencies coupled with high amplitudes for sorting materials with mainly coarse grading. In the literature ([1], [2]), there are guiding principles that recommend for the over-critical operation conditions *to adopt higher frequencies than those resulted from calculations, for the same amplitude.*

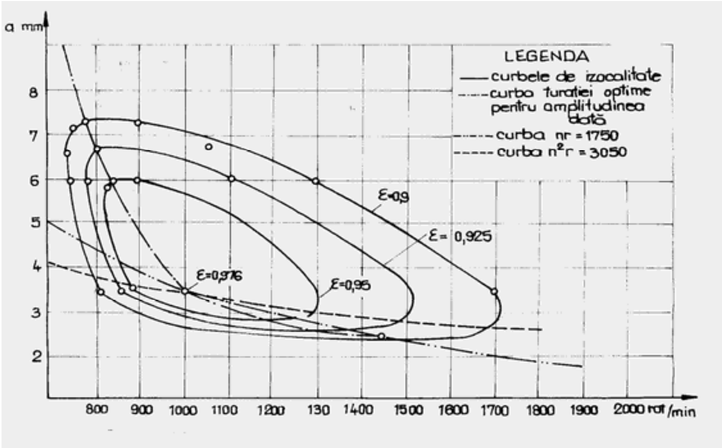

Fig. 1: Variation of the quality of screening depending on the amplitude and the frequency of the vibrations for 6.5mm mesh sieves [1].

That is why we recommend the choice of values of the parameters for the amplitude and frequency of the vibrations according to the nomographic chart or according to the tables of values determined experimentally. Several methods have been suggested in order to determine rapidly and simply the parameters of such optimum sieving conditions ([1], [2], and [3]). As these different parameters must be in certain interdependency, the use of some nomographic charts for the choice of all basic parameters of the sieves has been expanded. Thus, in the specialised papers several types of nomographic charts are being used for the calculus and the choice of the parameters in view of obtaining the optimum screening conditions, in order to observe the strict interdependency between them as well (Figure 2). Results from Figure 2 that the recommended pair of values amplitude↔frequency is [a=2.5mm, v=1200 rot/min]. From the recommendations mentioned above results the fact that the frequency can be increased at least up to the value of 1250 rot/min. Using another form of nomographic chart ([1]), one can obtain the necessary amplitudes of up to 5 mm for screening the materials with difficult screening.

2. THE CORRECT CHOICE OF THE BASIC DYNAMIC PARAMETERS OF THE SIEVE VIBRATIONS

Considering what was presented so far results the complexity of the phenomena that must be controlled in order to reach an optimum value in case of sieving the materials with critical humidity. From what was noticed in the activity of design, manufacturing and observing during the exploitation, one may draw the conclusion that the main way to solve this problem is to correctly choose the kinematic and dynamic parameters of the sieves. The choice of the optimum pair *frequency – amplitude* leads to obtaining the *maximum screening* *efficiency* ([3], [4]). The nomographic charts used so far do not refer specifically to screening materials with critical humidity.

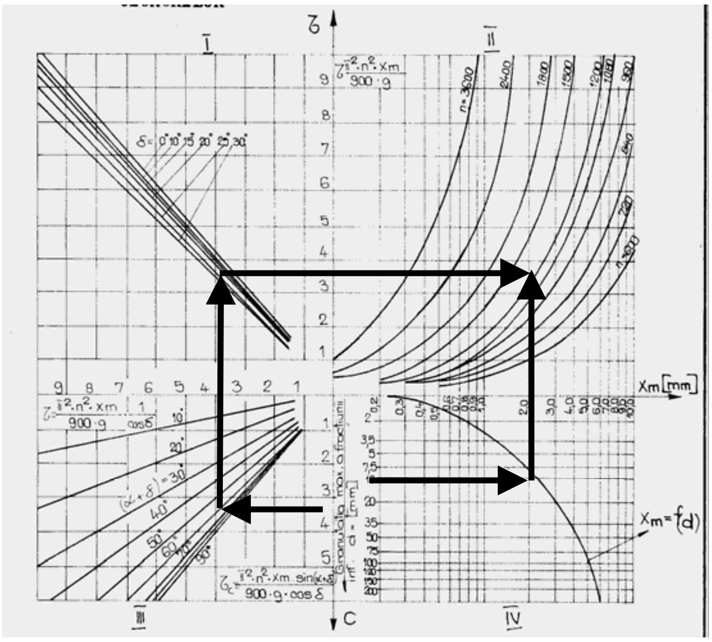

Fig. 2: Nomographic chart for the calculus of the main parameters for circular oscillations [2].

Personal theoretical and experimental contributions for establishing the best amplitude – frequency conditions in order to obtain a maximum *screening efficiency* in case of screening the materials with critical humidity is the case of this particular study ([4]). An experimental approach was used in order to find an optimal zone, where the pairs of the values of the rotation speed and of the amplitude correspond to the best quality of the screening. With that end in view, the screening efficiencies have been calculated when sieving on an inertial screen river sands and gravel, having the humidity in the critical zone.

3. METHODS AND RESULTS

The aim of the experiment was to calculate the screening efficiency for a range of values of the functional parameters frequency – amplitude of the considered screen, a range that should cover the values normally recommended in the literature for materials having the humidity outside the critical zone. Therefore we can conclude to what extent the usual values for the materials that are not included in the category of the critical humidity are also valid in case of materials with critical humidity.

The values measured for the frequency of the vibration **v** [min^{-1}], *the amplitude of the vibration* **a** [mm], *percentage inferior fraction in feeding the 10mm* α *[%] sieve*, as well as *percentage inferior fraction in the screen reject of 10mm* β [%] are given in the tables 5.1.1 – 5.4.4 from pages 113 – 118 in paper [1]. The screening efficiency η [%] corresponding to this value of the amplitude and frequency were calculated according to the formula:

$$\eta = \frac{100 \cdot (\alpha - \beta)}{\alpha \cdot (100 - \beta)} \cdot 100 \text{ [\%]} \tag{1}$$

The experiment was carried out at a working site of a ballast-pit that exploits aggregates taken from the bed of the Somes River, in order to determine the optimum conditions for the screens that sort critical humidity materials. The equipment on which the experiment was carried out is a $2m^2$ inertia screen, equipped with two screens of wire braid with 10mm and, respectively 4mm square mesh. The material that is usually screened in the ballast-pit is made up of aggregates found as alluvial sands and gravel. The minimum grain size is 0→5mm and the maximum one is 63→71 mm, with humidity between 5 and 25%, depending on the actual place where it was taken out. The concentration of adherent substances (loess and clay) is from 1.5 to 2%, with average abrasiveness. The experiment period covered both warm environmental temperatures (around 20°C) and lower temperatures (around 5°C). The measuring equipment that was used is a kit for measuring the amplitudes and a grading kit. The screen is equipped with two adjusting vibrators like in the ensemble drawing from Figure 3. The vibratory mechanism is designed and carried out by the author of this paper. The mechanism is thus devised that it permits both to adjust the amplitude of the vibration produced (by changing the relative position of the two counterweights of the eccentric – position 5), and to adjust the frequency of the vibratory mechanism (by changing the wheels of the driving sheave – position 7), which provides the covering of the zone by the usual kinematic parameters. The total mass in motion is *1250kg*.

The experiments have effectively measured the screening efficiency for four different values of the screen productivity: 60%, 80%, 100% and 125% of its rated productivity ($Q_{rated}=12m^3/h$). Four different amplitudes have been obtained with the help of the adjusting flywheels by modifying the relative position between the two counterweights that make up the eccentric o the vibratory mechanism for each of these flow rates. These amplitudes (according to Table 1) have been adopted using the existing nomographic charts in the literature and are valid for the materials having the humidity outside the critical zone. And each of these experimenting cases has been carried out for four different vibrating frequencies (800, 1000, 1250, and 1500 rot/min). On the whole, 64 measurements, covering randomly the usual zone of the vibrating parameters for screening on 10mm mesh sieves, have been carried out. The material having most of the grain size under 12mm was graded on the screen considered in the experiment, the humidity being included in the critical zone (5% - 14%).

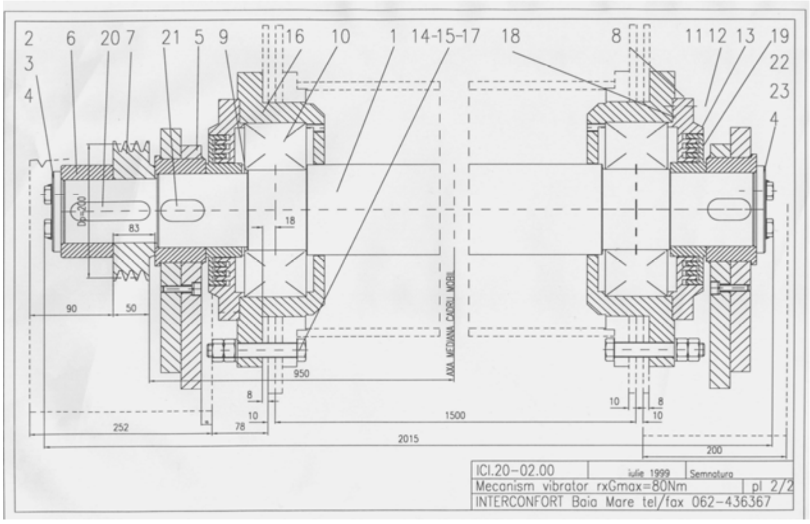

Fig. 3: The vibratory mechanism

Table 1: Amplitude cases used in the experiment

No.	**Adjusting angles between the flywheels**	**Perturbation torque**	**Amplitudes**
1	**0°**	**40 Nm**	**6.4mm**
2	**45°**	**34 Nm**	**5.0mm**
3	**90°**	**20 Nm**	**3.2mm**
4	**135°**	**9 Nm**	**1.5mm**

4. CONCLUSIONS

One can notice from the results of the measurements that the maximum efficiency has been obtained for the pair of values frequency – amplitude [v=1250min^{-1}; *a=3.16 mm*]. The values recommended by the nomographic chart from Figure 4 as being optimal for grading materials outside the zone of critical humidity on sieves having 10 mm mesh might be close to the pair frequency – amplitude [v = *1,250min*$^{-1}$*,,a=2.99mm*]. But one can notice that in this case we obtain only a screening efficiency η output of **85.7%**, as compared to a screening efficiency of **91.2%** obtained in the first case. These values seem to confirm the hypothesis that in case of screening materials with critical humidity higher amplitude must be chosen for the same frequency, in order to obtain a bigger shaking. In case of our experiment, the maximum grading efficiency was obtained at amplitude 6% higher than the nearest amplitude to the recommended one for the materials outside the zone of critical humidity. The results of the measurements carried out have confirmed in proportion of 85% the working and calculus hypotheses from this paper. Taking into consideration the multitude of aleatory factors that appear during the grading process and the approximations taken into consideration, this percentage can be considered a confirmation of these hypotheses and calculations.

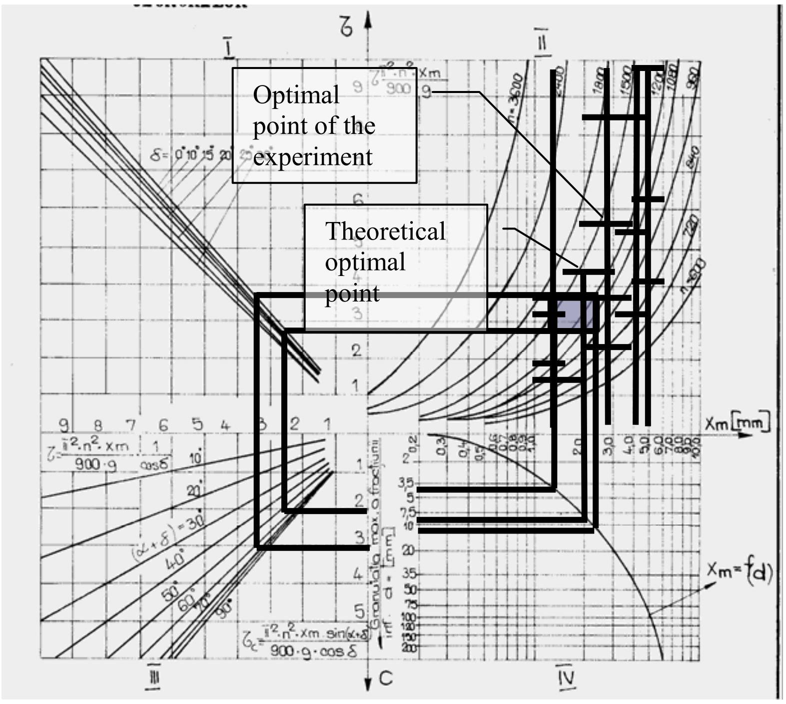

Fig. 4: The results of the experiments

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