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ACOUSTIC COUPLE MODELING FOR TESTING OBJECTS BY MEANS OF ANGLE-BEAM TRANSDUCER

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Expressions for the directional characteristic of ultrasound angle-beam transducer are obtained. Variety of these characteristics is calculated based upon obtained expressions. Some practical recommendation for reducing influence of instability of transducer – object acoustic junction is given.

Wide use information of opportunities of ultrasound in the not destroying control is caused by various conditions of distribution of elastic waves in environments with distinguished wave resistance. At analytical estimations of signals, arising at it, as a rule, the boundary conditions determining a continuity of taken into account making elastic displacement and stress on border of the unit are used. It corresponds to definition of conditions «of welded contact» which formation is not only possible [4]. The question on influence of quality of acoustic contact on информативность of the ultrasonic control is connected to a problem of creation and maintenance of reliable acoustic contact between the electro-acoustic converter and controllable product. Progress in creation of models describing influence of a degree of acoustic contact. Will allow more rationally to define parameters of the ultrasonic control, and hence is more realistic to treat its results, raising reliability of forecasting and increasing a degree of safety of operation of designs and materials.

In [4] the model of acoustic contact for border of the unit of two elastic environments, flexible connected among themselves is offered. It is supposed that the moving on this surface should be explosive. This condition on border of the unit of environments named «by a condition of linear sliding», replaces a condition of a continuity of moving.

In work [1] the mechanism of infringement adhesion is considered and the expressions describing a flexible degree of connection on border are given. The factors normal and transversal (KGN and KGT accordingly) rigidity can be equal from 0 up to ∞. The contact characterized by KGN, KGT →∞. Corresponds to continuous contact on border described by classical conditions. The contact at KGN, KGT→ 0 corresponds to formal transition to conditions of «free» border. There it is offered to write down factors KGN and KGT as KGN=$10^{12+0.2\bullet n}$ and KGT=$10^{12+0.2\bullet t}$. For practical accounts for the characteristic of rigid contact KGN, KGT = 10^{16} is accepted.

With reference to plane inhomogeneity system of factors of reflection and passage most full characterizes features of interaction and them of elastic waves. In view of boundary conditions in approximation of linear sliding, describing unrigidness connection on border of the unit a prism - media the expressions for account of factors of reflection and passage were received. As the quality of the control of products directly depends on a kind of the characteristic of an orientation of the converter, further was of interest to find out influence of acoustic contact on the characteristic of an orientation призматического of the converter. The characteristic of an orientation paid off in a plane of fall of the central beam [2] according to the formulas:

$$\Phi(\alpha, KG) = \Phi_0(\alpha) D_{lt}(\alpha, KG) \Phi_1(\alpha)$$

$$\left.\begin{aligned} \Phi_0(\alpha) &= \frac{2I_1\left[k_{l1}a\left(m\sin\alpha\cos\beta - \sqrt{1-m^2\sin^2\alpha}\,\sin\beta\right)\right]}{k_{l1}a\left(m\sin\alpha\cos\beta - \sqrt{1-m^2\sin^2\alpha}\,\sin\beta\right)} \\ \Phi_1(\alpha) &= \frac{\cos\alpha}{\sqrt{1-\ m^2\sin^2\alpha}}\left(\cos\beta\sqrt{1-m^2\sin^2\alpha} + m\sin^2\alpha\sin\beta\right) \end{aligned}\right\}$$

Where a - diameter piezoelement, $m = {c_{l1}}/{c_{t2}}$ - relation a speed of longitudinal wave in a prism to a speed of transversal wave in metal, $D_{lt}(\alpha, KG)$ - factor of transformation of a longitudinal wave in cross, taking into account an unrigidness of connection on border of the unit, β - an inclination angle of a prism, α - corner of refraction of a cross wave, k_{l1} - wave number on longitudinal waves in a prism, I_1 – Bessel function of the first order, KG - modules contact rigidness.

The accounts of the characteristic of an orientation were carried out depending on the following parameters: KGT, frequency (f), diameter piezoelement, inclination angle of a prism (b). The calculations were carried out by means of a mathematical CAD MatLab 2000. The value transversal rigidity varied from 10^{16} up to 0 (with a constant KGN = 10^{16}), that corresponds to transition from absolute rigid contact to a layer of a liquid. The frequency changed from 1,25 up to 5 MHz. The inclination angle of a prism varied in a range from first up to the second critical angle.

The dependence of the characteristic of an orientation on transversal rigidity value for aluminum is submitted on fig. 1.

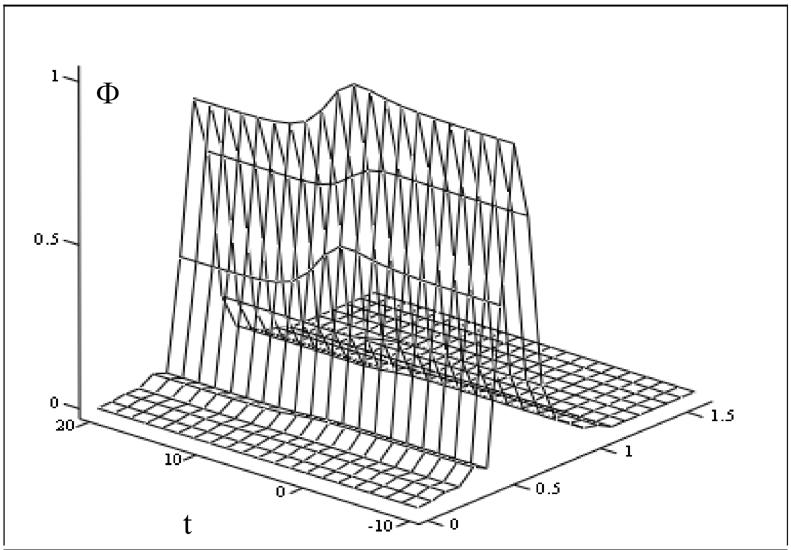

Fig.1.

Dependence between an orientation and transversal rigidity value. Aluminum. KGT varies from 10^{16} to 0. Frequency 1,25 MHz. Piezoelement diameter – 7mm.

It is obvious that at reduction of transversal rigidity the main maximum width is increased, the size of additional maxima is increased and at the same time there is an increase of the most important maximum. The accounts for steel at the same values of parameters give a similar picture. The difference exists only in absolute meaning. The fig. 2. is submitted the characteristics of an orientation depending on frequency of ultrasonic fluctuations.

As it is obvious from the given diagram at increase of frequency of fluctuations the main maximum is considerably narrowed. An additional maxima have similar behavior and only first additional maximum exceeds 0,1 from the maximal value. All other additional maxims at frequency 5 MHz practically disappear. However at this frequency the size of the main maximum approximately on 30 % is less than at frequency 1,25 MHz. Therefore at a choice of frequency it is necessary to take into account these both factors. Much obviously the diagram on fig.2a. On this diagram the characteristic of an orientation is given at KGN = KGT = 1012. All other parameters same as on fig.2. At presence by some flexible of border connection the reduction of size of the characteristic of an orientation appreciably is more significant. So the size of the characteristic of an orientation at frequency 5 MHz makes about 20 % from its size on frequency 1,25. Dependence for additional maxima same, as well as at rigid. From comparison fig.2. and fig.2a. it is visible as far as the account of rigidity on border of the unit of two medias is important.

Summary it would be desirable to note that by the important feature of all given here characteristics of an orientation (and also what are not given here) is asymmetrical which is kept and even amplifies at the unrigidliness degree of connection on border. Such feature of the characteristic of an orientation of the inclined converter is also marked in [2].

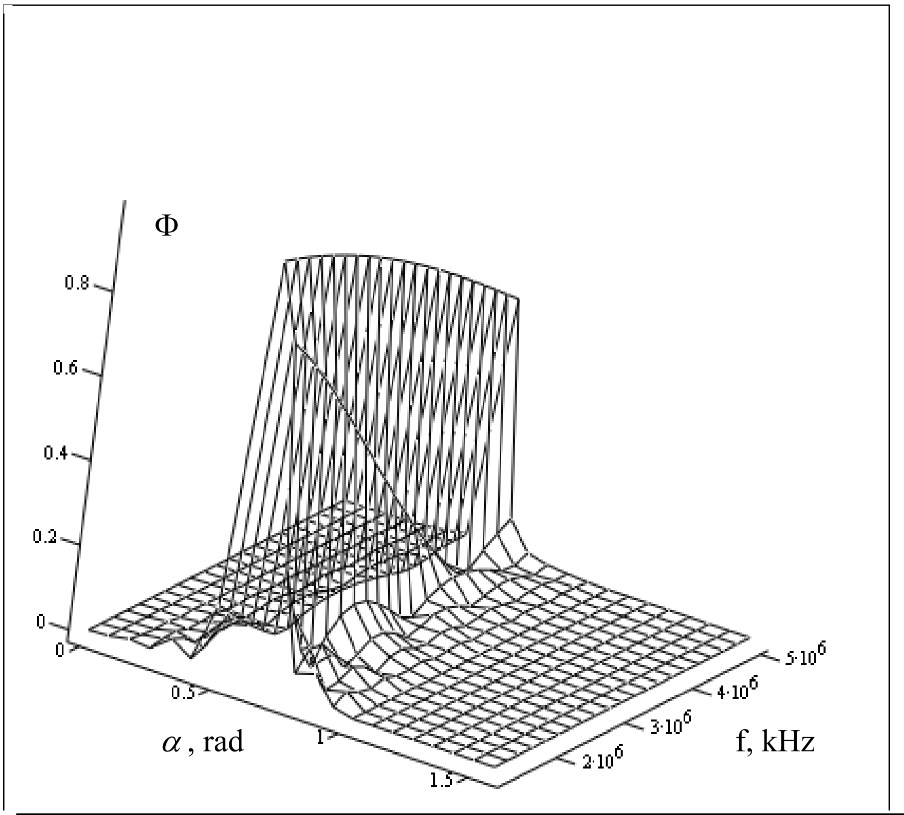

Fig.2.
Dependence between an orientation and a frequency. Aluminum. The frequency varies from 1,25 to 5 MHz. Piezoelement diameter – 7mm. KGN = KGT = 10^{16}.

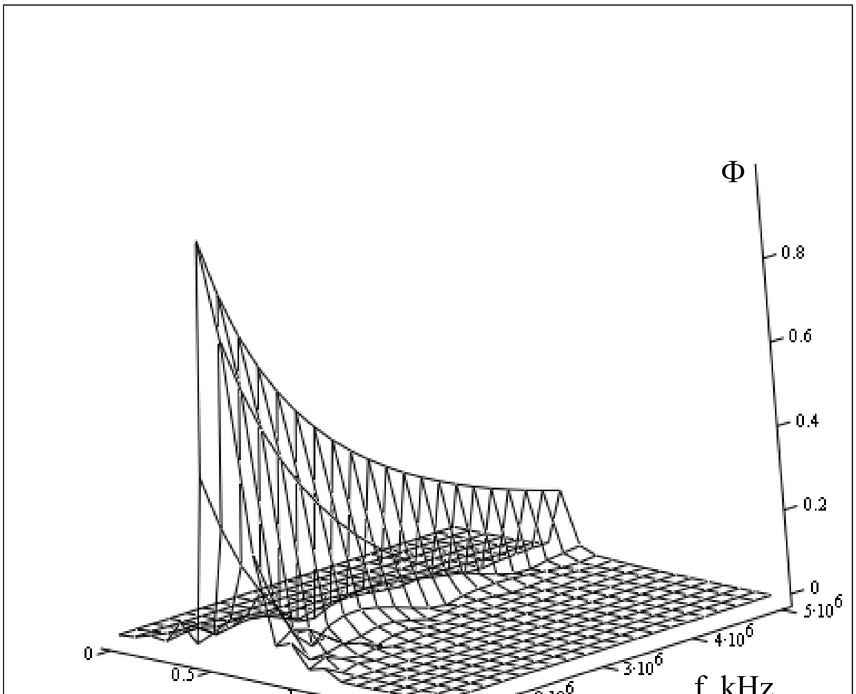

Fig.2a. KGN = KGT = 10^{12}.

From the above mentioned diagrams it is quite obvious that the quality of acoustic contact on border a prism - media essentially influences a kind of the characteristic of an orientation of the inclined converter. The basic characteristics of change of the characteristics of an orientation for various metals are qualitatively similar. The difference between them can be explained by a physical properties of materials.

R E F E R E N C E S

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