

1.3.42. REFLECTION OF LINEARLY POLARIZED SHEAR WAVES FROM THE STATISTICALLY ROUGH SURFACE OF CRACKS

Shcherbinskii V.G., Danilov V.N., Scientific Development and Production Center "TSNIITMASH", Moscow, Russia

The main task of the work was to estimate the parameters for field of transverse linearly polarized waves in the solid body on the scholastic reflector dispersion in accordance to the orientation of linearly polarization of waves relative to its surface.

Surfaces of sample breaks, like ST-3 (90 × 90 mm) which are used for estimation of brittle fracture at the multiple stressing during bend test can be applied as physical models of cracks.

Value of estimated parameters for distribution of asperities in 2 orthogonal directions in each 0.25 mm. was analyzed by the personal computers and compared with similar estimations for real cracks. This comparison revealed the significant proximity of static moments of asperities at the break surface and the values of the same characteristics of the real cracks [1].

This enables to take the surfaces of sample breaks as physical model of splits, the reflective characteristics of which are close to the appropriate real splits.

The rated model (heuristic) for estimation of shear-wave reflection factor from the statistically which is under consideration is supposed to be two-dimensional. Plane transverse monochromatic wave falls on the surface at the angle of "o", which is counted off the normal towards average straight line $z = 0$ [1]. The heterogeneous surface is supposed to consist of scattering linearly elements with their altitude assignment s_h according to the normal law with the average quadratic deviation $\bar{s}_h$ and assembly average m_{s_h} :

$$W(s_h) = \frac{1}{\sqrt{2\pi} \bar{s}_h} \exp \left[-\frac{(s_h - m_{s_h})^2}{2\bar{s}_h^2} \right].$$

Feature size along the average straight line is equal to l_h and connected to the height s_h by the some functional relation, the form of which in shape of regressive formula is defined by the experiment data and usually connects the average quadratic values $\bar{s}_h$ and $\bar{l}_h$ (correlation window). The obtained in the work [1] linearly approximation of the next relationship $\bar{s}_h = q_h \bar{l}_h$ is used for the calculations below, where the proportionality factor q_h , equal to 0,11 according to [1], could be some more or less of this value.

The definition of the scattered by the element wave amplitude was realized in the Kirchhoff approximation for the acoustically soft reflector with the extent l_h . In this case the amplitude ratio of SV-wave reflection has next form:

$$R_{i,\varphi}^{SV} = \sqrt{\frac{\int_{l_h}^2 \{ \cos \theta_0 I_{i,\varphi}^{SV} [\theta_0, (\theta_0 - \theta_h)] \}^2 W(s_h) ds_h}{\int_{l_h}^2 W(s_h) ds_h}}. \quad (1)$$

The integration in the formula (1) takes place in area of counted changes of values s_h (usually in the dimension of $6\bar{s}_h$), θ_h – angle of rough element inclination [1], I^{SV} – dispersion of transverse wave indicatrix, indexes “o, 3” mean the dispersion in reverse and mirror directions. The report contains results of simulation for influence of some of parameters change on relative amplitude ratios $\frac{R_o^{SV}}{R_\phi^{SV}}$ and $\frac{R_o^{SI}}{R_\phi^{SV}}$ of reflection from the statically rough surface SV and SH of transverse waves.

The experiment was held on the sample of triangular section with the angle apical 80° . Herewith the angle of incidence on the surface of break was 50° and corresponded with the real conditions and parameters of control over weld beads. The transformer with quartz plate of y-cut on rate of 2.0 MHz, which was radiating linearly polarized waves, and special adjusting device were used. The amplitudes of the reverse signal A_{opp} and signal A_3 , which was reflected from the rough surface and opposite smooth boundary at the different orientation of polarization vector, simulating the scoring SV and SH , as well as at the angle of 45° , were measured in each point.

Totally, the results of the experiment prove the validity of the developed theoretical model: reverse and mirror reflection ratio is significantly lower than 1. Its connected with the waves type relatively weak, but really depends on the Relay parameter P_R ; reverse reflection ratio for SH / SV waves is significantly higher than 1, what causes the better detectability of SH splits by waves. For the mirror signal A_3 this relation is reverse and practically significantly decreases proportional to the parameter P_R . This probably is explained by the waviness phenomenon, which is not taken into consideration during calculations. Constants of variation $v(A_3) \angle v(A_{\text{opp}})$, what shows the significant statistic stability of the mirror signal. This a priori defines the high accuracy of measurement of equivalent area according to A_3 .

References:

1. **Shcherbinskii V.G.** The research of statistical parameters of roughness and reflective characteristics of weld beads splits // Flaw detection. – 1985. – No 11. – pp. 9 – 20.