1.3.72. NEW ASPECTS OF EXCITATION AND PROPAGATION OF SUBSURFACE LONGITUDINAL AND TRANSVERSE WAVES

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Subsurface waves (SW) – longitudinal (SLW) and vertically polarized transverse waves (STW) excited at critical angles of incidence β_i of an ultrasonic beam find increasing application in ultrasonic inspection [1, 2]. Taking into account the wide possibilities from the previous type of wave application and real output problems, we could conclude that it is necessary to study the laws of STW and SLW mode excitation and propagation in the solids of different geometric and boundary conditions at the interface surface. In this work we study, predominantly, peculiarities of SW formation in solids: A) with protective layer of h thickness; B) in solids with projection.

A) Iinterference phenomena arise when the SW modes are exciting and propagating nearly interface boundary protective layer-metal base. The protective layer of $h^* = h / \lambda$ thickness under the probe-emitter (or receiver) can be considered as additive resonance "wave guide element" with wavelength λ_p. Experimental data on amplitude of SW modes dependence P_A vs. wave frequency ν, different probes positions and the aim of the object "sounding" have been obtained. As there show, amplitude function $P(h^*)$ is oscillating one, and amplitude variation can be ~10 – 12 dB. The method of the acoustical path stabilization when interference phenomena in protection layer to be appear has been developed. So, to diminish oscillation of P_A vs. h^* we suggest to use the additive acoustical echo-canal (path), created by normal probe installed in a common corps and its amplitude of reflected mode $P_0 \sim P_{SW}$ if the wave frequency is determined from the derived formula $\nu_c = \nu f(\Delta\vartheta, \beta, C_{SW} / C_i)$, where C_i – sound velocity in the protective layer and in probe material, $\Delta\vartheta$ – phase shift while reflection. Interference phenomena arise too when the protective layer is fluid and SW mode propagates along interface. It was revealed, that the pulse function $P(h^*)$ can be varying up to 14–15 dB and if a ratio of the acoustical impedances (solid base-fluid) is lesser 10 and the layer opposite surface is free or rigid. In such conditions we observe substantial pulse deformation. It should be noted that this interference phenomena can be used to measure physico-mechanical properties of test solids.

The peculiarities of an acoustical field formation in an object with a projection have been revealed as a function of a curvature radius of a fillet transition and Rayleigh wavelength λ_R. The simplified physical model of forming the acoustical two-dimensional field $\Phi(\alpha)$ of STV wave emitter probe in solids with a step projection and fillet transition is developed. It is based on the representation of $\Phi(\alpha)$ as a superposition of the fields of two coherent sources: the principal mode (Φ_T) and the secondary mode transformed at the fillet transition from the accompanying Rayleigh wave – $\Phi_R(\alpha)$. By experimental study the coefficient K_R of the Rayleigh mode transmission through the fillet transition and the coefficient of its transformation into volume transverse one $K_{RT} \sim P_A$ against radius of the fillet transition was determined (fig. 1). It was revealed that for $R^* = R/\lambda_R << 1$ the characteristic width ϕ of $\Phi_R(\alpha)$ taken at a level of 3 dB decreases as $\varphi \sim\nu^{1,7}$ over the frequency range $\nu = 1 – 4$ MHz. As our laboratory finding and theoretical analysis show

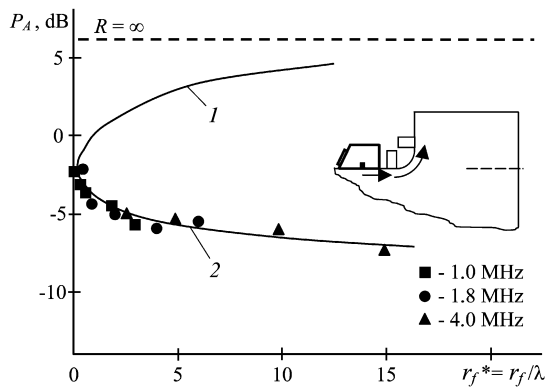

Fig. 1. Rayleigh wave amplitude transmissed through fillet transitions (1) andamplitude of the STV mode, transformed of Rayleigh wave at fillet transition (2):
□, ○, Δ – experimental date

the phase shift Δφ between principal STV mode and RW one transformed into the transverse volumetric mode (TV) causes more substantial $\Phi(\alpha)$ changing. The data of suggested model calculations of $\Phi(\alpha) = \Phi_R(\alpha) + \Phi_T(\alpha)$ (fig. 2) are in good qualitative agreement with experimental data. It was shown too that sometimes it is possible to inspect the former objects by using RW probes and TV mode transformed at the fillet transition. The projection inclination to contact surface of the object causes K_R, K_{RT} and $\Phi(\alpha)$ varying vs. an angle inclination.

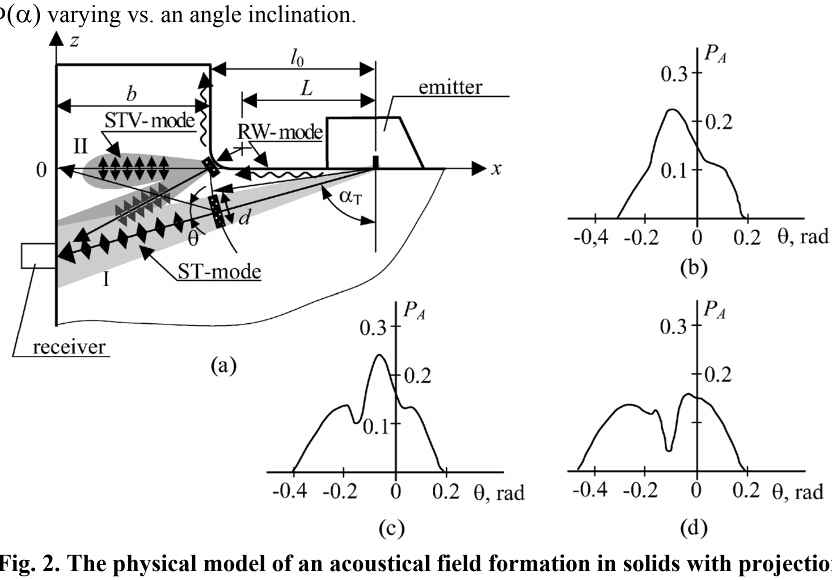

Fig. 2. The physical model of an acoustical field formation in solids with projection and fillet (a) and dependencies P_A vs. θ (b-d); the phase shift between STV and RW mode $\Delta\Psi_{SR}$ = 0,7π (b); 1,8π (c); 2,7π (d)

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