F016 P- AND S-WAVES IN DISCRETE MEDIA WITH INTERNAL FRICTION

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The discrete media are known to have a set of points - concentrators where Hooke's law is invalid. In granular media these points are located at the edges of grain contacts, in cracked media — at the edges of cracks. Normal forces acting perpendicular to the contact surface make no singularities in the stress field whereas tangent forces acting along the contact surface result in singularities around the edge of the contact. In order to eliminate these phenomena, Mindlin, Deresevich and Johnson have created the model of partial creeping at the surface of contact. This model predicts the area of creeping as well as the fact that dissipation energy is proportional to the third degree of deformation. This results in the hysteresis loop on the stress-strain diagram which can be approximated by ellipse and its area is the dissipation energy. Using these results, the Lagrange function which includes creeping, can be created.

Furthermore there is no equivalence between finite difference and differential operators in discrete media because of finite range of their microstructure. Taking into account creeping and finite range of grains (or, in cracked media, average distance between a crack and its nearest neighbour), we can create the non-linear fourth order equation of motion. The discreteness of medium results in the dispersing term while internal friction results in the non-linear term. If non-linear and dispersing terms are small, the equation can be reduced to the third order equation similar to that of Korteweg-de-Vries (in one-dimensional situation), but, unlike the Korteweg-de-Vries equation, the non-linear term in this equation is pure imaginary. Neither solitons nor cnoidal waves appear in this one-dimensional situation, but there is attenuation (especially for S-waves) and difference in frequencies between P- and S-waves. This frequencies difference is growing with distance. As we can see, the wavelengths of P- and S-waves tend to become equal in limit. Using characteristic co-ordinates $\xi=t-x$, $\eta=t+x$ we obtain the equation of motion (for deformations u) as

$\frac{\partial u}{\partial \eta} \pm i\varepsilon u \frac{\partial u}{\partial \xi} - \beta \frac{\partial^3 u}{\partial \xi^3} = 0$, where ε depends upon normal forces, contact radius, and friction coefficient. For infinite friction coefficient $\varepsilon=0$. The value β depends upon the radius of grain and wavelength. In cracked media the physical sense of ε is different but the form of the equation remains the same.

In fig. 1 the changing of P- and S-waves spectra is shown. The curve I presents identical initial spectra of P- and S-waves at the distance $x=0$. The curve II presents the P-wave spectrum at the distance of 3 wavelengths. The curve III is the S-wave spectrum at the same distance.

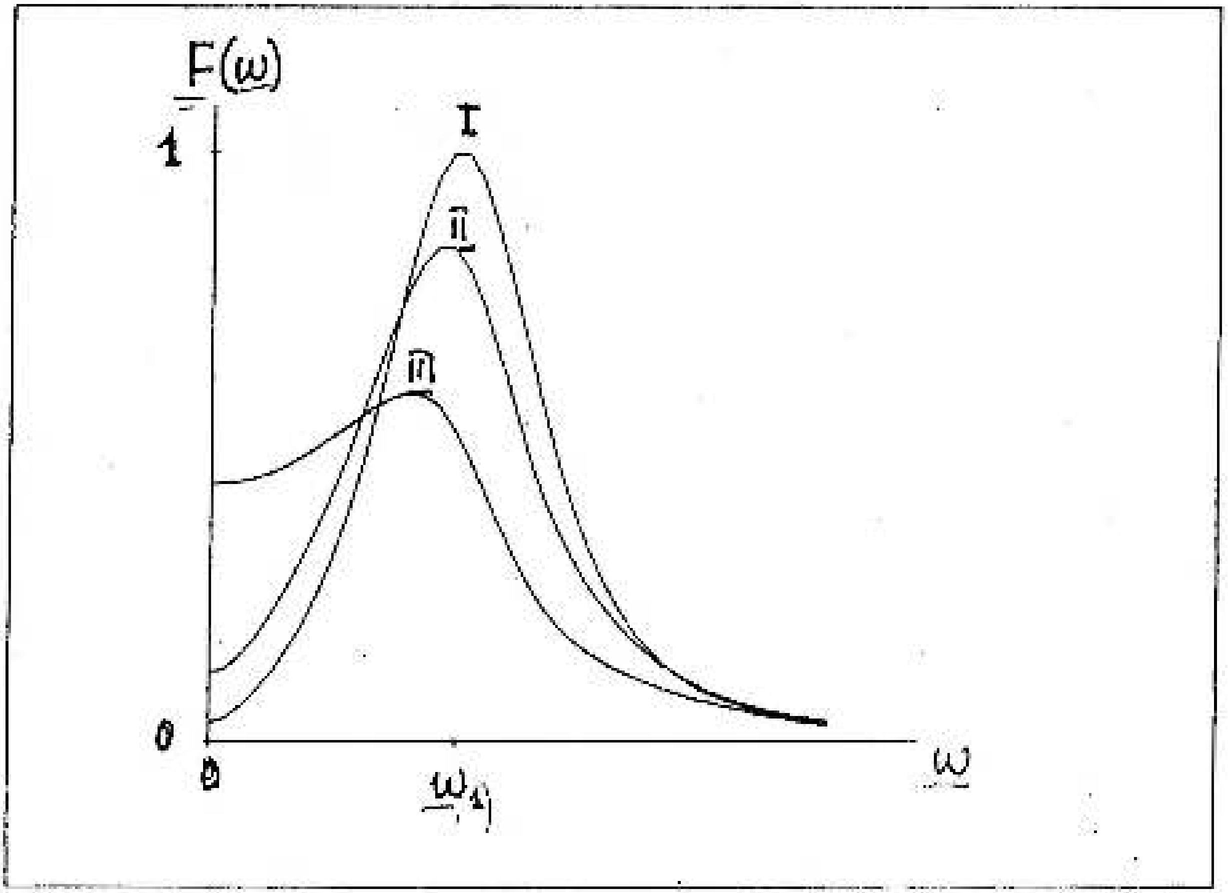

Fig 1